CLASSIFICATION OF SCHEDULE MANAGEMENT BARRIERS THROUGH CONCEPT MAPPING

THESIS

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Abstract

Barriers to adoption of schedule management processes are a matter of serious concern to the acquisition community. Schedule management has been widely accepted to contribute to the successful execution of complicated system development processes since the 1950s. However, studies of recent acquisition failures illustrate that over the last 15 years, there has been significant internal resistance to the adoption of schedule management processes. This exploratory effort used concept mapping to identify and classify the types of barriers existing in the Aeronautical Systems Center (ASC). A series of open-ended questions were posed to four experienced program managers in ASC. Units of Analysis were extracted from the survey responses, and grouped and sorted by a representative set of proxy sorters. Multidimensional scaling was applied to the sorted groups to indentify affinity of the responses, and cluster analysis was employed to identify emerging themes from the program manager responses. The results indicated 10 barrier groups, which can be mapped using two conceptual axes (internal-external, and tactical-strategic). As a result of this analysis, a series of focused recommendations are provided to the ASC Acquisition Center of Excellence to improve acceptance and adoption of schedule management practices.

Acknowledgements

 Looking back on this thesis experience I remember the beginning when it appeared to be a monumental task with undefined expectations and me with no idea of where begin. Having finally made it through to the end of that experience I owe a great deal of thanks to several individual for their guidance and patience through this tremendous learning process. First, my committee chair, Lt Col Patrick Kee, for patience through the lengthy process of trying to settle on a manageable topic, advice on how to attack a research effort, encouragement, and feedback along the way. I have to thank Lt Col Dean Vitale for identifying a research method that fit the research question well, bringing the effort into focus. Finally, I have to thank Maj Robb Wirthlin for the feedback and critique of my writing.

Gregory W. Voth

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I.   Introduction

1.1 Background

This research effort began with a phone call to the US Air Force, Aeronautical Systems

Center, Acquisition Excellence office (ASC/AE) in the spring of 2008. It was during this

brief conversation that the head of the ASC/AE office mentioned that an initiative to

improve schedule management was just beginning within ASC. The reason for the

initiative was that ten years before, ASC leadership recognized that their programs were

routinely being accomplished well beyond their baseline schedule dates. Ten years later

performance had not improved. One of the key observations was a general lack of focus

on schedule management within the organization. Program managers were not able to

explain schedules during program reviews, various program planning documents did not

line up with the schedule, and the program schedules when used were so inaccurate they

held no credibility. This is not a new phenomenon, as indicated by comments in a 1993

thesis that researched schedule management in ASC. "As a general comment, the

management of schedule is not well understood within the SPOs" (system program

offices) (Hazeldean & Topfer, 1993). To remedy the situation, a team was formed to

analyze the root of the problem and form a plan for improving schedule management

within ASC. The author was allowed to be part of that team, and this research was done to support ASC's schedule initiative.

Within the Department of Defense (DoD), organizations such as ASC manage the procurement of major new weapon systems for the military and modifications to existing systems. The need for an organization like ASC to complete programs on schedule is important for two significant reasons. First, the user community portion of DoD doesn't see any utility from the investment until a system has been fielded. Schedule management assists the organization in fielding programs as soon as possible by identifying the optimal sequence of activities to achieve the program objectives. Second, program delays cost money. For example, a 2000 General Accounting Office (GAO) report on the national missile defense program noted that at the then current spend rate, every month the program was delayed cost an additional $124 million (GAO, 2000). Cost overruns on programs like the missile defense program take money away from other budget priorities. A review of 75 major defense acquisition programs in 2000 found an average 16 months' delay in delivering capabilities along with a 6% cost growth from baseline estimates. In 2008, a similar review of 95 major programs found the average schedule delay had grown to 21 months along with a 26% cost growth (GAO, 2008). While difficult to put a value on a 21-month delay in delivery, we can get some perspective from the $295 billion on cost growth found in the 2007 portfolio of programs. $295 billion is over four times the total $65 billion cost of the F-22 Raptor program through 2008 (GAO, 2008) (Drew, 2008). Assuming that a portion of those cost overruns are directly related to program delays, the value of effectively managing program schedules becomes apparent.

1.2 Research Problem

The question this research effort is attempting to answer is: What are the barriers to effective schedule management faced at the program manager's level? In order to answer this question, project management and scheduling literature was reviewed to determine what schedule management is and its origins. Also, research was reviewed to find out if schedule management really does improve overall program success. Finally, the results of a search for similar research are presented.

1.3 Research Objectives

1.3.1 Classify Potential Barriers

The first objective of this research was to collect and analyze data from program managers within ASC in order to identify what schedule management barriers are faced by program managers. Data was collected from multiple program managers and analyzed to identify categories of barriers. By diagnosing the barriers to schedule management organizational change efforts may be focused to achieve the greatest effect.

1.3.2 Test Utility of Concept Mapping

A secondary objective of the research was to test the utility of a method termed concept mapping as a means of analyzing a complex organizational problem.

1.4 Research Method

A survey was used to collect data from current ASC program managers. The survey used open ended questions to garner the program managers' perspective of what barriers are

faced in managing a program schedule. The data was analyzed using the concept

mapping method. The method provided a means of combining qualitative data from

multiple sources and then synthesizes the interpretation of data by numerous people. The

process creates concept maps which are a visual representation of the people's combined

assessment of the data (Trochim & Cabrera, 2005).

1.5 Organization of Study

The remainder of the thesis is divided into four chapters and an appendix. The next

chapter is a review of the schedule management literature. Then the research method will

be discussed, followed by a presentation of the data and results of analysis. The final

chapter presents conclusions and recommendations based on the results of the research.

II. Literature Review

2.1 Chapter Overview

This chapter covers a review of literature for the purpose of establishing a common understanding of schedule management, determining the value of schedule management, and identifying gaps in previous research on barriers to implementing schedule management. In order to provide a foundation for the discussion, the origins, processes, and measures of effective schedule management are presented. The value of schedule management is shown through previous research, which measured the impact of schedule management on overall program success. Finally, a review of previous research on barriers to effective schedule management found that the topic is relatively unexplored and provided an opportunity for further investigation.

2.2 What is Schedule Management?

The term *schedule management* as used in this thesis describes a process. The meaning is consistent with project time management as defined in the Project Management Institute's (PMI) Guide to the Project Management Body of Knowledge (PMBOK). The author uses the term *schedule management* to remain consistent with the research sponsor. Schedule management covers the processes involved with ensuring timely completion of the project. These processes include: activity definition, activity sequencing, activity duration estimating, schedule development, and schedule control (PMI, 1996). Figure 1 depicts where the schedule management processes occur in relation to overall project management processes. As shown in the figure, all schedule management processes except for schedule control occur in the planning phase of a

program. A significant portion of the project planning process includes schedule

management processes. The project schedule is an important piece of the project plan,

which then forms the basis of project executing processes. The project execution is

controlled through the controlling processes, of which the final schedule control is a

significant piece (PMI, 1996).
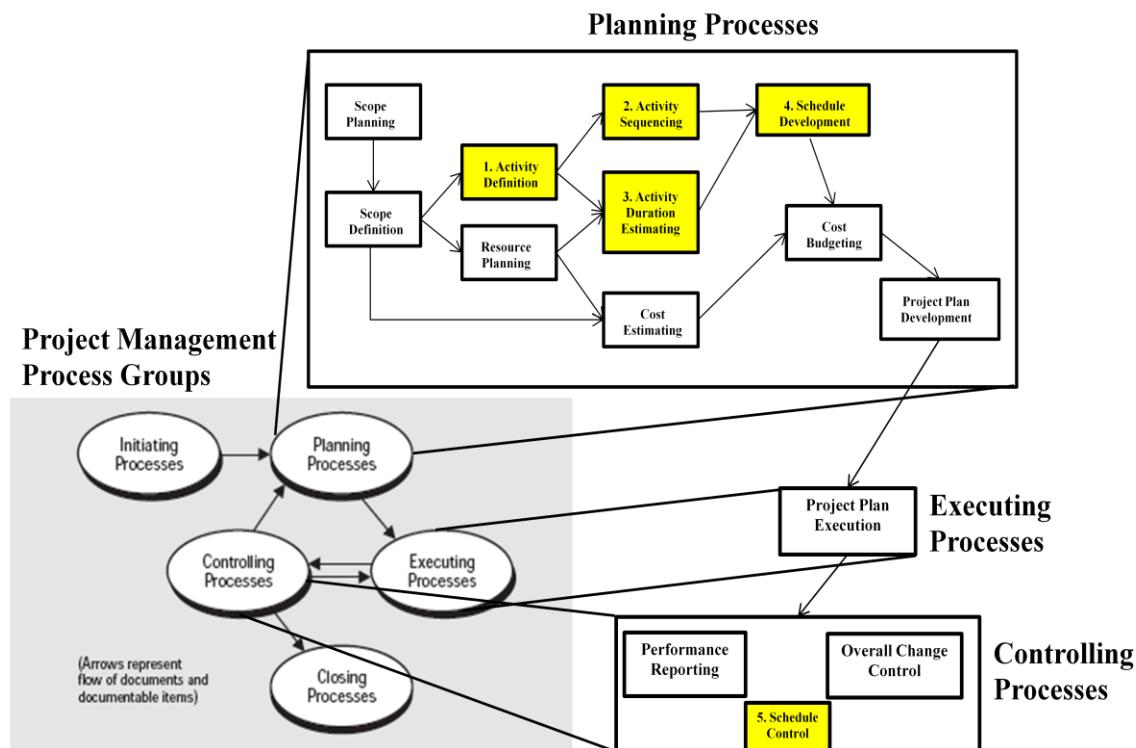
Figure 1 Relationship Between Schedule Management and Project Management
Processes (PMI, 1996)

Schedule management serves several purposes. Estimates of project duration early in the

project lifecycle can be used to make decisions on project selection. Later in the project

lifecycle, estimated completion times can contribute to decisions on whether or not to

continue or kill a project (Cooper, Edgett, & Kleinschmidt, 2001). Also, schedule

management helps the project manager coordinate and facilitate the efforts of the project (Cleland, 1990).

Project planning, of which a significant portion is schedule development, is a thinking process (Cleland, 1990). The output of the planning process, the project plan, documents the objectives of the project (scope) and the judgment of the planning team on the way to achieve those objectives. By understanding schedule management as a process, it is differentiated from project schedule and schedule analysis techniques. The project schedule is a document whereas schedule analysis techniques are means of making assessments of duration, risk, trends, and resources among others (Majerowicz, 2002).

The project schedule is a graphic representation of the activities necessary for the completion of the project (Cleland, 1990). The schedule can take numerous forms, from exceptionally detailed network and Gantt charts to Post-it Notes on a wall. Firms such as Toyota and Hewlett Packard have shown that even a schedule as low tech as Post-its on a wall can be successfully used in product development (Maylor, 2001). To be effective, a schedule should meet the criteria listed in Table 1.

Table 1 Criteria for Effective Project Schedule (Cleland, 1990)

1. Understandable to the project team.
2. Capable of identifying and highlighting critical work packages and tasks.
3. Updated, modified as necessary and flexible in its application.
4. Substantially detailed to provide a basis for committing, monitoring, and evaluating the use of project resources.
5. Based upon credible time estimates that conform to available resources.
6. Compatible with other organizational plans that share common resources.

Schedule analysis techniques have been developed to better determine the expected

length of the project. The most commonly used analysis techniques are Critical Path

Method (CPM) and Program Evaluation and Review Technique (PERT). Both processes

determine the longest chain of activities required to complete the project as a way of

getting a better estimate of the completion date. The difference between the two is that

CPM uses a fixed estimate of the time to complete each task while PERT calculates the

activity duration as a spread from most optimistic estimate to most pessimistic estimate

of time (NetMBA). The origins of CPM and PERT will be discussed further in the next

section. While CPM and PERT proved to be an improvement over earlier practices, they

still routinely provide inaccurate estimates of project completion, especially when task

durations are uncertain (Ahuja & Thiruvengadam, 2004). New techniques have been

developed for handling various common situations such as activity duration, uncertainty,

concurrent engineering, and others (Ben-Haim & Laufer, 1998) (Peña-Mora & Li, 2001)

(Goldratt, 1997). Today, the standard schedule analysis method for DoD is CPM

(OUSD(AT&L)ARA/AM(SO), 2005). The fact that DoD is still focused on CPM could

be because it is relatively simple and broadly applicable or reflect that little attention is

given to applying and advancing the ability of schedule management within the program

offices.

2.2.1   History of Modern Schedule Management

The 1940s marked the turning point from the machine age to the systems age (Blanchard

& Fabrycky, 2006). The transition occurred in how people sought to understand the

world around them. The machine age was dominated by reductionism and mechanism

thinking. *Reductionism* is the belief that problems can broken down to smaller individual parts. Understanding the problem as a whole is then accomplished by adding the sum of the parts. *Mechanism* is the belief that all phenomena can be explained by cause and effect relationships. In contrast, the systems age is denoted by synthetic thinking, or the belief that something can be explained by understanding its role in a larger system (Ackoff, 1974).

The entry into the systems age saw the development of extremely complex systems, which spurred the development of new management tools, including systems engineering and project management. In fact, both the systems engineering and project management disciplines trace their roots to the 1950's development programs (INCOSE, 2000) (Blanchard & Fabrycky, 2006) (Cleland, 1990) (Leavitt & Nunn, 1994). Within project management, significant focus was put on how to manage project schedules. During the late 1950s the development of ballistic missiles and space systems were considered essential for national defense. Intense competition between the military services and their contractors drove the development of project schedule analysis tools to help ensure both mission success and project success (technical performance, delivery schedule, and cost control). During this period PERT was developed by Booz Allen Hamilton and used by the Navy in developing the Polaris A1 submarine launched ballistic system (INCOSE, 2000). A similar process, CPM, was developed 6 to 12 months prior to PERT by DuPont Corp for managing the shutdown and restart of chemical plants in order to accomplish maintenance (Weaver, 2006) (Kelley & Walker, 1959) (NetMBA).

According to Patrick Weaver's work on the history of project scheduling, the continued development of project scheduling was closely tied to the development of computers. Large organizations that could afford mainframe computers had staffs of scheduling experts to operate the complex computer systems. The result was that the organization had a centralized staff of scheduling experts driven to create high-quality schedules. When desktop computers finally became popular in the 1980s and 1990s, the widespread availability of planning software enabled anyone to become a scheduler. This resulted in the scheduling staffs being dispersed and the quality of project schedules declined. Today the trend is back toward centrally controlled schedules viewable by project team members (Weaver, 2006).

2.3 Does Schedule Management Work?

Examining research on project management shows that project planning and use of a project schedule significantly contribute to the probability of project success. As identified above, project schedule development is a significant part of project planning; therefore, literature addressing the value of project planning is discussed along with research targeting project schedules specifically. Literature is consistent that at least some level of project planning is necessary for project management (Tzvi, Shenhar, & Dvir, 2003; Cleland, 1990; Defense Acquisition University; Kerzner, 1992; Lewis, 1991; Project Management Institute, 2000; Roman, 1986). For research and development (R&D) programs where project schedule, cost, and overall satisfaction with the development process is a critical measure of project success, the lack of a detailed project schedule is a significant predictor of project failure (Pinto & Mantel, 1990). In a study on

the impact of plan and goal changes on project success, quality planning had a (0.27) positive impact on the project's efficiency and (0.14) impact on customer satisfaction (Dvir & Lechler, 2004). A limitation of Dvir and Lechler's work is that the quantities, (0.27 and 0.14) are not defined, but it is inferred that they represent a measurable relationship between quality of project planning, project efficiency, and customer satisfaction. The measure of quality planning used in Dvir and Lechler's study is shown in . Five of the six items relate directly to the project schedule. Only item five could be considered an output from the planning process not directly related to the project schedule.

Table 2 Measures of Quality Planning (Dvir & Lechler, 2004)

1. The entire project task (scope) was structured in work packages.
2. Every work package was allocated with a specific time allowance.
3. We knew which activities contained slack time or slack resources.
4. All work packages had a predecessor and a successor work package (except the first and the last).
5. There was a detailed budget plan for the project.
6. The precise demand for key personnel (who, when) was specified in the project plan

In a separate study identifying project success factors, Dvir found that use of a schedule and milestones was critical to achieving project cost and schedule goals (Dvir, Lipovetsky, Shenhar, & Tishl, 1998). In a review of 13 studies measuring the effects of project planning, all showed a strong or medium positive effect on project success (Lechler, 1997). A 1997 review of project management literature found that inadequate planning was the most frequently cited reason why projects fail with 36 mentions (Nikander & Eloranta, 1997).

2.4 Barriers to Effective Schedule Management

A literature search was conducted to find any previous research on the topic of barriers to effective schedule management. The search reviewed the articles in the Journal of Scheduling from the first volumes in 1998 until 2008. The International Journal of Project Management was reviewed from its first volume in 1983 through April 2009. The Project Management Journal was reviewed from March 1985 through June 2008. After not finding any related research in these journals, a multi-database search was run. This search turned up one thesis (Hameed, 2005) and a report on reengineering the project planning process at a Swedish construction firm (Andersson & Johansson). Beyond this, minor mentions in books and articles about potential barriers to schedule management are discussed. All are covered in further depth below.

2.4.1   Hameed

In October 2005 Aftab Hameed completed his thesis on barriers to resource-driven scheduling within Malaysian construction firms (Hameed, 2005). In his research, a survey was sent to construction firms in Malaysia to identify the level of use of resource-driven scheduling within their organizations and the impediments that prevented the use of resource scheduling. Resource-driven scheduling was measured by the company's level of implementation of resource-driven scheduling features in their project management software. Of the software used by the companies, 64.9% used Microsoft Project, 17.5% used Primavera Project Planner, with the remainder using bar charts, Gantt charts, or work breakdown structures. Use of nine software features were measured including: resource options, resource calender, assigning resources to activities, resource

priority, resource leveling, resource smoothing, resource splitting, resource stretching, and resource crunching options. Responses from 57 professionals in the Malaysian construction industry found that 59.6% of the firms only partially used resource-scheduling features.

Through literature review and interviews with managers in the construction industry, the following list of barriers was created:

Table 3 Barriers to Resource-Driven Scheduling (Hameed, 2005)

a.	Not Everyone Knows and Understands Project Schedule
b.	Expensive to Prepare
c.	Difficult to Prepare
d.	Have No Guidance to Follow Concerning Preparation
e.	Hurdles by Personnel/Authorities
f.	Impediments Due to Interference
g.	Too Many Numbers of Resources
h.	No Enforcement on Schedules From Authority
i.	Lack of Knowledge for Planning
j.	No Training Session
k.	Budget Allocation
l.	Exhaustive (can only be solved using computer software)
m.	Complexity of the Project
n.	Uncertainty Value
o.	Resource Availability

Using the list of barriers from the literature review and interviews, Hameed sent a survey to identify which of the barriers provided a more significant impediment. The results of the survey indicated:

> "Lack of knowledge, no training session, budget allocation, and
> uncertainty values were very significant barriers/constraints.

Not everyone knows & understands project schedule, expensive to prepare, difficult to prepare, has no guidance to follow concerning preparation, hurdles by personnel/authorities, complexity of the project, too many number of resources and no enforcement on schedules were significant constraints."

One challenge in comparing Hameed's work to the research being undertaken here is that Hameed focused on barriers to a small piece of the overall schedule management process, resource scheduling. The problem identified by ASC was that programs were having challenges in implementing the overall schedule management process.

There are several shortcomings of Hameed's research. First, the items on his list of impediments are not well defined. Impediments such as (e.)- hurdles by personnel/authorities, (f.)- impediments due to interference, and (k.)-budget allocation are rather ambiguous and may be interpreted several different ways. Second, very little information is given on how the categories were created. Data was collected during interviews of Malaysian construction managers, but no insight is provided on how many interviews were conducted, what the positions were in the industry, what the levels of experience were, or what the process was for analyzing the data and settling on the final list of impediments.

2.4.2   Andersson & Johansson

Another document examined in depth was an undated report by Niklas Andersson and Patrick Johansson. Andersson was a doctoral student at the School of Civil Engineering

at Lund University in Sweden, while Johansson was project engineer at Skanska Syd AB, a Swedish construction firm. The report was a case study of current project planning processes at a Skanska Syd AB with the intention of identifying areas for improvement (Andersson & Johansson). Their case study found that project planning was given a low level of importance among a majority of the project and company managers. The study used a model depicting various factors influencing the project planning output, shown in Figure 2. This model was used to frame the discussion for the status of planning within the company. The model depicts four key factors affecting the planning process: company management, understanding motivation, knowledge proficiency, and control systems. As the project schedule is a significant output of the planning process, the model could help explain factors affecting the use of schedule management; however, there was no discussion on the basis for using that particular model or where it came from. It is likely that the model is valid as it proved useful for the case study, but the question remains whether it captures the full range of factors affecting the planning process and schedule management.
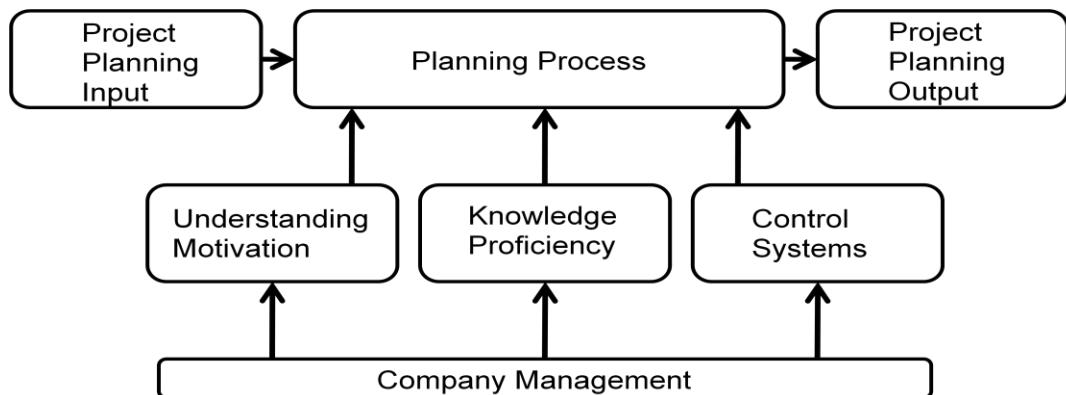
Figure 2 Company Input and Control on Project Planning Output (Andersson & Johansson)

Observations during the case study provide some insight to what occurs when effective project planning and schedule management is not done. In general, Skanska project managers considered project planning to be too time consuming; schedules were made to get a rough picture of how to organize activities and what resources were needed. Most project managers produced a number of schedules with differing levels of detail and no mutual connection for the same project. Managers had difficulty understanding that the various schedules were all different reports of the same project. They found that planning outputs such as the schedule do not always serve as a foundation for decisions and communications. Schedules with limited information were made due to tradition rather than to monitor the project. The majority of project managers did not fully use the schedule to forecast and manage project risks.

There are two major limitations of Andersson and Johansson's work regarding its use to answer the current research question: What are the barriers to implementing schedule management? While they used a model showing four factors that influence project planning—and therefore project schedule development—no basis for the model was provided. There is no assurance that the model is valid or that it accounts for all potential barriers. Second, their focus was only on the project-planning phase. This leaves out factors influencing schedule control during the execution phase of the project.

2.4.3   Scheduling Research Articles and Project Management Books

Having identified only two papers that indirectly addressed potential barriers to schedule management, the search was expanded to find comments made in books and papers that

referenced reasons why schedule management may not be adopted or done effectively within an organization.

2.4.3.1 Scheduling Requires Skilled and Dedicated Resources

Literature indicates that building and maintaining schedules for large programs can require significant effort or even a dedicated staff (Roman, 1986) (Weaver, 2006) (Ahuja & Thiruvengadam, 2004). The dedicated staff brought a depth of knowledge on scheduling and techniques. The result was a higher quality product (Weaver, 2006). This is supported by previous AFIT research, which concluded that special training and education may be required to fully exploit schedule management tools (Brown, 1995) (Hazeldean & Topfer, 1993).

2.4.3.2 Inaccurate Schedules

While the project management literature and research reviewed support schedule development as a means of controlling and improving project performance, the literature also makes it clear that schedules are not perfect. As projects are unique endeavors, accurately planning all of the activities necessary to complete the project at an early stage is difficult if not impossible (Andersen, 1996). Often data does not exist for estimating task durations. Expert opinion may be the best estimate available, leaving the entire schedule only as accurate as the opinions of the experts (Leavitt & Nunn, 1994) (PMI, 1996). This is especially true in high-risk projects (Roman, 1986). Techniques for analyzing the schedule duration such as PERT and CPM are frequently inaccurate or may leave the program team with a false sense of security (Roman, 1986) (Maylor, 2001)

(Ahuja & Thiruvengadam, 2004). These methods lose utility especially in situations where system requirements shift until late in the project (Roman, 1986). History has shown that major unpredictable events can impact project implementation. Projects must remain flexible to deal with such events (Rozenes, Vitner, & Spraggett, 2006).

2.5 Summary

The literature review found that schedule management needs to be viewed as a process extending from the planning through execution phases of the project. A significant portion of the project-planning phase is involved with identifying the activities, arranging them in a logical order, assigning resources to accomplish the activities, and developing the project schedule. Once the execution phase of the project begins, the schedule becomes a tool for monitoring progress, directing execution, and estimating completion times of the project.

The results of 17 project management research efforts support that there is a strong positive relationship between project planning and schedule management with overall project success.

A search of available literature turned up limited research and other information regarding barriers to using schedule management within a program. This suggests a gap in the available knowledge and prime opportunity to conduct some research on the question.

III.   <u>Research Method</u>

3.1 Chapter Overview

This chapter explains the research method used and why it was selected for this study. Following is a detailed description of the process used to collect the data for this research. Then the process used for analyzing the data will be presented.

3.2 Method

Data was collected using a survey and then analyzed via the concept mapping process. Concept mapping is a multi-method process that results in a graphic representation of the combined thoughts of the participants (Trochim, 1989). The process was selected for identifying potential causal factors because the process is inductive, enabling shared meanings to emerge from the input of many participants (Trochim & Cabrera, 2005). It is an inductive method, meaning that in this case it allowed the research to move from specific experiences and observations by several current program managers to draw general conclusions about the categories of barriers faced across the organization. This is contrasted with standard hypothetical deductive-based research methods, which start with a general concept, the hypothesis, and then test for specific instances which will either support or refute the hypothesis (Schwab, 2005). Similarly, content analysis methods require the analyst to create a construct (hypothesis) for coding the textual data (Krippendorf, 2004). For both statistical and content analysis research, the results will always be limited by the hypothesis created by the researcher. Use of an inductive process provides a better opportunity for discovery of emergent categories at the expense

of the strength of the conclusions. The process may be useful in enabling multiple

participants to contribute to the inductive building of a theoretical construct, which can

then be deductively tested after measures are created for the emerging concepts

(Valentine, 1989). The overall research process is modeled in Figure 3.

This research is not intended to be the definitive work on barriers to schedule

management. It is being conducted as an exploration on the subject focusing on the

potential factors within a single organization and using a method that has not been

applied to the problem before.
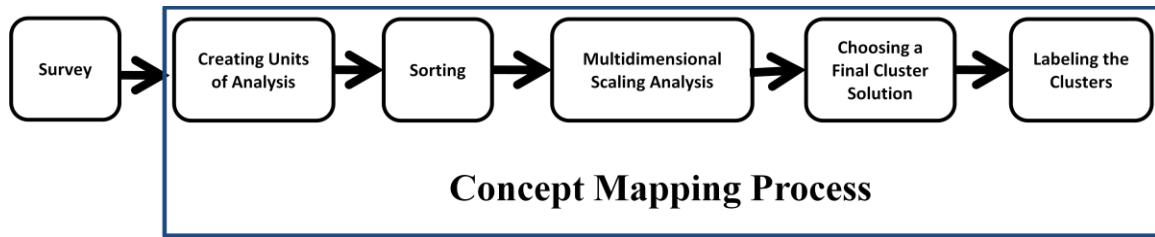
Figure 3 Research Process (Jackson & Trochim, 2002)

3.3 Data Collection

Data was collected via a questionnaire e-mailed to program managers within ASC. The

questionnaire contained three open-ended questions designed to elicit the program

manager's observations as shown in Table 4. Only the answers to the questions on

weaknesses of current schedule management practices and causes of ineffective use of

program schedules were used in the final analysis because these questions drew answers

best matching the intent of the research effort. The question on strengths of current

schedule management practices was asked only to identify if there were any elements of current practices that should be preserved after ASC's schedule initiative. No strengths in the current practices were identified.

Table 4 Research Questionnaire

1. What are strengths of current schedule management practices?
2. What are weaknesses of current schedule management practices?
3. What causes ineffective use of program schedules?

The questionnaire was directed at program managers because they are the individuals on a program given the responsibility and authority to accomplish program objectives. The program manager is accountable for cost, schedule, and performance reporting to the milestone decision authority (USD (AT&L), 2003).

The ASC Program Managers Council identified respondents through a call for research that volunteers sent out. This is a council of functional leaders and senior program managers within ASC. The council requested two volunteers from each wing. This generated ten responses for the researcher. When the questionnaire was sent out, four responses were received for a 40% response rate.

3.4 Analysis Process

In the concept mapping process, once the raw data is collected there is a five-step process for analysis as depicted above in Figure 3. The rest of this section will detail the steps of the concept mapping process.

3.4.1 Creating Units of Analysis

Units of analysis for the concept mapping process consist of a sentence or phrase

containing only one concept (Jackson & Trochim, 2002). Data collected from participants

that is not already in such a format must be converted to a unit of analysis suitable for the

concept mapping process. Two primary challenges are faced in unitizing textual data. The

first challenge is to prevent alteration of the data during the process. This can occur if the

meaning of the text is lost or changed during the process of unitizing the data. The second

challenge is to ensure reliability of the data. This means that the process should be

repeatable by others and provide similar results. The author developed the rules in Table

5 for unitizing the data. This was done to ensure the reliability of the data and minimize

bias of the researcher on the data.

Table 5 Rules for Unitizing Data

a. If the text was provided as a short statement not in sentence or paragraph form the text will be unitized as is.
b. For text supplied in sentence and paragraph form, each sentence became a unit of data.
c. If the sentence was written in passive voice it was converted to active voice.
d. If the sentence used pronouns referenced from elsewhere in a paragraph the unit of data was written with the proper noun replacing the pronoun.
e. If the sentence listed multiple items the data units were written as multiple individual statements referencing one item.
f. Repetitive statements from the same source were not used.
g. If the source recommended a solution to a problem, the issue the solution was aimed at correcting was used as the unit of data.

3.4.2 Sorting

The sorting process is a means of collecting information on how each of the units of

analysis (statements) are related to each other (Trochim, 1989). Individual participants

contribute their perspective of how statements are organized or interrelated (Trochim & Cabrera, 2005). An unstructured card-sorting procedure was used to collect information on the relationship between statements as explained further in this section (Rosenberg & Kim, 1975). A minimum of ten people is recommended to accomplish the sorting process (Jackson & Trochim, 2002).

Using the same people who contributed the statements to do the sorting is recommended but not always possible, as was the case in this research effort (Jackson & Trochim, 2002) (Trochim, 1989). In case the original contributors are not available to do the sorting process, proxy sorters may be used in their place. The following considerations were made when selecting proxy sorters (Jackson & Trochim, 2002).

a. How their background and experiences are similar/different to the respondents and how that might influence their interpretation of the units.

b. Any theoretical background/understanding underlying the research topic that they have in common with the respondents and how a deeper/lesser understanding of that theory may influence interpretation.

c. The degree to which existing theoretical frameworks can provide a basis for comparison in gauging the degree of difference between respondent content and proxy sorter groupings.

Details of the process for accomplishing the sorting used in this research effort are as follows. Each unit of analysis was numbered and transferred to an individual note card. The number assigned to each unit of analysis was written on the back of each card. This

prevented the numbers assigned to each unit from influencing the individuals who sorted

the cards. Individuals sorting the cards were given a brief background description of the

research and the questions used to generate the statements. The participants were then

instructed to group statements together that they felt were related. There were no

restrictions placed on how this was to be done other than every statement could not be its

own individual pile and there could not be a single pile containing every statement. If the

individual felt that an individual statement did not fit with any other group, it was to be

left as its own individual category. The individual should not create a pile of random

unrelated statements. After the individual sorted the cards, he/she was instructed to

provide a name for each pile of cards, which described the overarching concept each of

the statements fell into. For each pile, the name of the pile and number of each of the

statements within the pile was recorded.

The results of the individual sorts were analyzed by comparing the number of categories

each proxy created. This was used to determine if there is an outlier that may be excluded

from the final analysis (Jackson & Trochim, 2002).

3.4.3   Multidimensional Scaling Analysis

The objective of multidimensional scaling analysis is to combine each of the sorts and

create an output, which represents the sum of the judgment of every sorter (Jackson &

Trochim, 2002; Trochim, 1989; Valentine, 1989). The process begins by creating a

binary square matrix where the number of columns and rows matches the number of

statements being sorted for each sort accomplished. Each time a statement is grouped

together by the sorter, a (1) is placed in the cell corresponding to the row and column associated with each statement. All other cell values are (0). Once the matrix is built for each sort, the matrices are combined into a single matrix by summing the numbers in each cell. The value of each cell in the combined matrix may range from (0) to (10). Cells with higher numbers represent statements that were sorted together more often. Lower numbers represent statements that were grouped together less often, with (0) representing statements that were never grouped together (Jackson & Trochim, 2002) (Trochim, 1989). Multidimensional scaling analysis is run on the aggregate matrix.

Multidimensional scaling analysis creates a graphic representation of the relationship between the statements. In this case, a 2-dimensional map is created that depicts each statement as a point with the associated statement number. Statements that were sorted together more often are closer together on the map while statements that were sorted together less frequently are spaced farther apart.

3.4.4   Choosing a Final Cluster Solution

The output from the multidimensional scaling is analyzed using hierarchical cluster analysis. Clusters are groups of statements that mapped closer together during multidimensional scaling analysis due to their being sorted together more frequently. One way to understand the clustering process is to consider each statement as its own cluster. The number of clusters is then reduced one by one through a process of combining the closest statements in order. By analyzing the statements within the clusters, the overall meaning of that cluster can be identified. While the cluster analysis is the result of

mathematical algorithms, in this case Ward's algorithm, the final number of clusters is a subjective judgment on the part of the researcher. According to Trochim, "There is no sensible mathematical criterion that can be used to select the number of clusters" (Jackson & Trochim, 2002). The final number of clusters was determined by creating a 30 to 8 cluster replay and using two decision tools created in the process. A cluster replay is done by starting with a higher number of clusters and then reducing the total number of clusters one at a time and tracking which clusters merge in order. The decision tools created by this process are the list of statements contained in each of the 30 clusters and a list of the order in which the clusters are merged down to eight remaining clusters (Jackson & Trochim, 2002). By examining the statements that are combined as the clusters are merged, the researcher decides if the combination makes sense.

3.4.5   Labeling the Clusters

Once the final cluster solutions are determined, the statements within each cluster were analyzed to create an appropriate label. Common terms and themes are identified in the statements, which contribute to the overall cluster label.

3.5 Validity

Establishing the reliability and validity of a research effort is critical for determining if the results are usable (Krippendorf, 2004). Validity, determined by whether or not how and where the data was gathered, is relevant to answering the question at hand. For this effort the question is: What factors are causing ineffective schedule management? Questionnaires were sent to current program managers within ASC who are managing

programs in the development phase. This was done to ensure the validity of the data.

First, data was collected from program managers because they are the individuals on the

program held responsible for meeting schedule, cost, and performance goals. Schedule

management is a way for the program manager to ensure that the program is meeting

schedule goals, and it gives the program manager information for taking corrective

actions. Current program managers were used to ensure that the data reflected the

situation as it exists today within ASC. Program managers only within ASC were used to

ensure that the results reflected the situation within ASC in support of the ongoing

scheduling initiative. While generalization of the results is limited by sampling from only

one organization, the results may still be applicable outside of ASC to the extent that the

situation in those organizations is similar to that of ASC. Because of the common

processes and regulations guiding every DoD acquisition center, the results of this

research reflect the situation of those organizations as well.

3.6 Reliability

Reliability is an important factor to consider when conducting research. To ensure that

data accurately represents the truth it should be constant throughout changes in the

measuring process (Kaplan & Goldsen, 1965). Reliability is a function of the process of

analyzing the data. The following is a useful framework for discussing reliability of

content analysis. "There are three types of reliability: stability, reproducibility, and

accuracy" (Krippendorf, 2004). Stability relates to the degree that the process is

unchanging over time. Reproducibility is related to the degree that the process can be

replicated under different circumstances. Accuracy relates to the degree that a process

conforms to its specifications and yields the results that it is intended to yield. The following table shows the researcher's assessment of the reliability of this research effort. Strategies used to correct for a lack of reliability are described after the tables.

Table 6 Assessment of Research Reliability

		Data Collection	Creating Units of Analysis	Sorting	Multidimensional Scaling	Cluster Analysis	Naming Clusters
Types of Reliability	Stability		X		X	X	
	Reproducibility		X		X	X	
	Accuracy		X		X		

Research Stages

Creating units of analysis and the multidimensional scaling stages are assessed to be the most highly reliable. The reliability of creating units of analysis is a result of following the rules described above. Multidimensional scaling is reliable because it a purely quantitative analysis of the results of sorting using mathematical algorithms. While the process for collecting data was reliable, the results of the data collection may not be. To improve reliability of the data collection, multiple program managers were sampled. The sorting process is similar in that the process used can be repeated, but the results of each individual sort cannot be verified to be repeatable. For this reason the final analysis is based on a sample of 10 sorts. Cluster analysis is deemed stable and reproducible but the final result may be judged to be inaccurate due to the human judgment used to determine the final number of clusters. To counter this, the process used is described in detail and the researcher's judgment is documented, enabling the reader to make his/her own evaluation. Naming of clusters is also deemed an unreliable step due to the level of

human judgment involved. Again, the thought process is documented to allow others to review and determine accuracy of the researcher's effort.

3.7 Summary

This chapter covered the research method used for this effort, reasons for selecting the method, and details of how the research was carried out. A brief discussion of issues of reliability and validity of the data was also presented.

IV.   Results and Discussion

4.1 Chapter Overview

This chapter will present the results of data collection and analysis using the processes described in chapter three. Results will be presented in order of the research process as shown in Figure 3. There will be a discussion of the results at the end of the chapter.

4.2 Results of Data Collection

The data collection effort resulted in responses from four program managers within ASC. Each had between 17 and 20 years of experience as a program manager.

4.3 Creating Units of Analysis

The responses to questions two and three from each participant were combined and unitized. The result was a list of 112 statements displayed in Appendix A. This list constitutes the data set for the research. While the number of respondents was relatively low, their responses were detailed enough to generate an acceptable number of statements for the concept mapping process. Practical limitations are encountered if the data set is much larger. A limitation of the methodology is that the process of sorting the statements can become overwhelming for data sets containing over 100 statements (Trochim, 1989). This can lead to the sorters being reluctant to participate, or they'll put in less effort as they progress through.

4.4 Sort Results

Eleven proxies were used to sort the statements. Eight of the eleven sorters were Air Force program managers. Of the remaining three there was a scientist, finance manager, and schedule analyst, each with 20 or more years experience in defense acquisitions. The time to accomplish the sort required approximately 45 minutes per person.

The data collected from the sorts was reviewed to determine if there were any outliers to exclude from the multidimensional scaling and cluster analysis. At first the data was reviewed based on the number of categories generated in each sort. The results of this analysis are shown in Table 6. The table shows two columns for number of categories created. The # of Categories column tallies the number of categories created in each sort. The mean number of categories created was 10.45 per sorter. The next column shows the number of categories created excluding the categories containing only a single statement. The results of this analysis showed that the mean number of categories created dropped to 9.27. Sorts (I) and (K) were the only ones with single-statement categories. Analyses including all of the categories created left sort (K) as an outlier. When the single-statement categories created by sorts (I) and (K) were left out, the number of categories by sort (K) was near the mean, and sort (I) fell outside of the standard deviation by approximately 0.32 categories. While sorts (I) and (K) were each an outlier depending on the way the number of categories was counted, the researcher determined that based on category counts each was still acceptable. A review of the category names generated during each sort did reveal that one, (I), was indeed and outlier. The sorter (I) grouped 40% of the statements into two categories labeled "whining" and "whining plus

problems." The individual was not a program manager and the responses indicated either

the process may not have been taken seriously or the individual had a very different

perspective on the issue. For this reason sort (I) was left out of the final analysis.

Table 6 Analysis of Data Sorts

Sorter ID	# of Categories	# Categories Excluding Single Statement Categories
A	10	10
B	9	9
C	9	9
D	12	12
E	11	11
F	7	7
G	8	8
H	11	11
I	9	5
J	12	12
K	17	8
Mean	10.45454545	9.272727273
Standard Deviation	4.647212673	3.947101837

4.5 Results of Multidimensional Scaling

The results of multidimensional scaling analysis are shown in Figure 4. A standard

measure of the multidimensional scaling analysis is the stress index (Kruskal & Wish,

1978). The stress value is an indicator of how well the multidimensional scaling map

represents the data. A lower stress index value indicates less distortion in the map. The

stress index for this analysis was 0.33793. Meta analysis of 37 concept-mapping projects

demonstrated a mean stress index of 0.285 with a standard deviation of 0.04. The

maximum stress index was 0.352 (Trochim, 1993). The stress index for this effort was

within the range observed during previous concept mapping efforts. The author was not

able to find any criteria establishing a limit to the maximum stress value allowable for a concept mapping effort.

 The proximity of the points relative to each other represents the strength of the relationship between the statements. The distances reflect how often the statements were sorted together during the sorting process. Positions of statements on the map, (top, bottom, left, or right) carries no meaning.
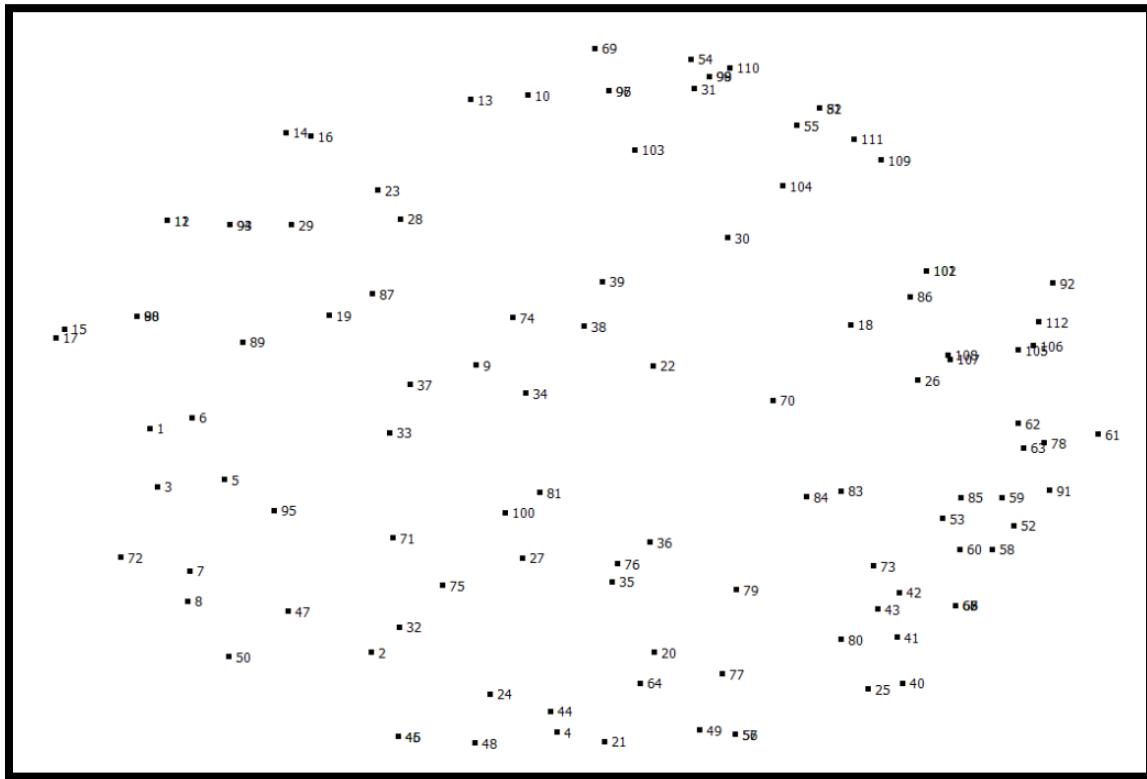
Figure 4 Results of Multidimensional Scaling Analysis

4.6 Results of Cluster Analysis

The final number of clusters was determined by running a 30 to 8 cluster replay and analyzing the statements combined together as clusters were merged. The 30-cluster map

is displayed in Figure 5 and the statements within each cluster can be found in Appendix

B. As the number of clusters was reduced they merged in the order shown in Table 7.
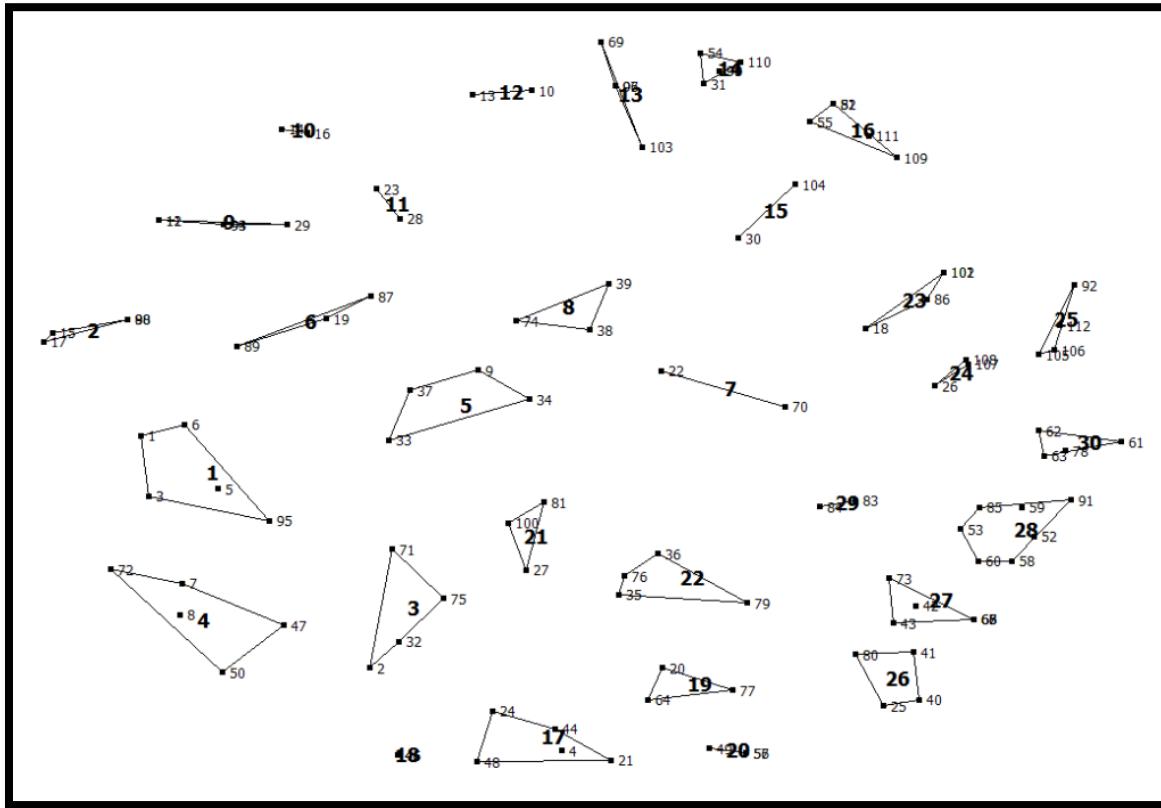
Figure 5 30-Cluster Map

Table 7 Order of Clusters Merged During 30 to 8 Cluster Replay

At Cluster 29 merged: 12 13	At Cluster 18 merged: 28 29
At Cluster 28 merged: 10 11	At Cluster 17 merged: 9 10 11
At Cluster 27 merged: 19 20	At Cluster 16 merged: 28 29 30
At Cluster 26 merged: 24 25	At Cluster 15 merged: 12 13 14
At Cluster 25 merged: 15 16	At Cluster 14 merged: 3 4
At Cluster 24 merged: 7 8	At Cluster 13 merged: 1 2
At Cluster 23 merged: 17 18	At Cluster 12 merged: 5 6 7 8
At Cluster 22 merged: 26 27	At Cluster 11 merged: 17 18 19 20
At Cluster 21 merged: 21 22	At Cluster 10 merged: 12 13 14 15 16
At Cluster 20 merged: 23 24 25	At Cluster 9 merged: 17 18 19 20 21 22
At Cluster 19 merged: 5 6	At Cluster 8 merged: 26 27 28 29 30

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The researcher determined that the final cluster map would contain ten clusters. This decision was made because the merger of cluster (17/18/19/20) with cluster (21/22) to achieve a total of nine clusters would combine two clusters that contained separate and distinct concepts. The decision was to preserve each of these clusters as independent concepts. The final 10-cluster map is displayed below in Figure 6 and the statements within each cluster can be found in Appendix C.

Figure 6 Final 10-Cluster Solution
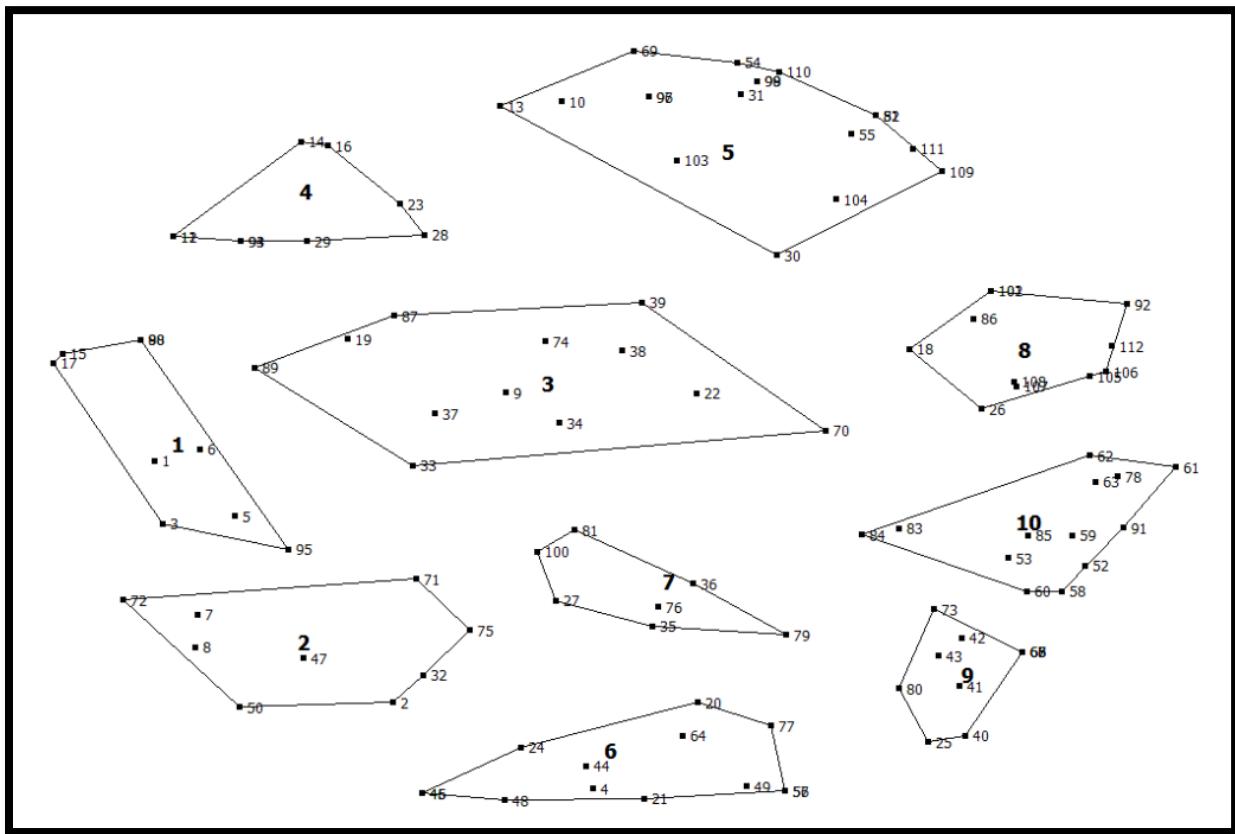
4.7 Results of Cluster Labeling

The cluster labeling process is done to provide a definition for each cluster. Analysis is done by reviewing the statements within each of the final ten clusters to identify a unifying theme which ties the statements together. The remainder of this section will give the name assigned to each cluster with a brief discussion of the statements within the cluster.

4.7.1   Cluster 1. Complex Interactions

Cluster 1 contained 9 statements. Within the statements phrases such as "synchronization" and "consensus of stakeholders" along with "communicating and vetting requirements decisions" indicated that schedule management requires buy-in from numerous people on key decisions. Also, four statements reference root cause analysis or "how things will become depends on understanding how things got this way." These statements imply that there is an interaction with past and future events, which needs to be understood. The last remaining statement in the cluster describes the importance of the "relationship between risk management, cost management, and schedule management." Together the statements within the cluster describe a complex environment with many interconnected pieces necessary to manage a program.

4.7.2   Cluster 2. Low Perceived Utility Compared to Cost

Cluster 2 contained 9 statements. Statements within this cluster had varied themes. One referenced not wanting to be held accountable (personal cost). Another described costs of a contractor developing the schedule (financial cost). Other statements describe the

schedule as not user friendly for quick updates and not useful in briefings. Two statements refer to design to cost indicating that there is more benefit in watching the program budget versus the program schedule. This may imply that the schedule is not as useful because management attention is not on the program schedule. Overall the researcher interpreted the statements as describing a cost of using schedule management along with a perceived lack of utility for schedule management.

4.7.3   Cluster 3. Lack of Program Team Cohesion

Cluster 3 contains 12 statements. The statements were evenly split, with six making reference to teams and team issues while the remaining six covered a lack of or difficulty in achieving the following: communication, synchronization, consensus, and expectations. Together all of these statements were interpreted as referring to issues within the program team, which contribute to difficulties in managing the schedule.

4.7.4   Cluster 4. Effect of Changes and Risks

Cluster 4 contained nine statements. Seven of the statements contained the terms "requirements changes," "schedule anomalies," "programmatic risks," "unanticipated delays," and "assumptions on task durations." The remaining two statements refer to resource decisions. Overall the theme of these statements indicates that changes and risks during execution have an impact of schedule management.

4.7.5 Cluster 5. Lack of Manpower and Time

Cluster (5) contained 18 statements. The statements generally discussed a lack of manpower, the amount of time required to perform schedule management, and the time constraints present. These statements were interpreted to represent a lack of manpower and time available to properly accomplish schedule management.

4.7.6 Cluster 6. Lack of Disciplined Program Management

Cluster 6 contained 13 statements. Four of the statements discussed senior management focus on the very top level program schedule "cartoon schedule," and the lack of focus on program schedules in general. Another statement, "ASC abandoned the scheduler skill set years ago," can also be inferred as a leadership issue. Three statements refer to "seat of the pants" program management. The remaining statements used the following terms: "unfocused," "mishandling," "neglected," and "incompletely." The researcher interpreted all of these statements to reflect a lack of disciplined program management, which extends from the senior management levels down to the program managers.

4.7.7 Cluster 7. Negative Incentives for Using Schedule

Cluster 7 contained seven statements. Of these, four of the statements clearly indicated that the schedule might represent a negative incentive. Statements such as, "Team members tend to avoid supporting schedule development and maintenance to avoid expectation that they have 'bought in' to the schedule," and "comfortable for team members to hide in anonymity of team without accountability," indicate there may be an issue. One anonymous program manager summed it up as, "The program schedule

becomes a tool for senior management to beat you over the head when you fail to meet milestone dates." Another statement, "…could add cost to program if contractor manages schedule," would be a reason to not use a schedule if the program budget is tight. Also, "…contractor reporting the schedule that is on contract and not what they know to be a more realistic schedule," reflects some incentive for the contractor to not present a realistic schedule to the government.

4.7.8   Cluster 8. Inaccurate Schedules

Cluster 8 contained 11 statements. Eight of the 11 statements mention "errors," "not accurately," and "not accounted for." The remaining statements reference "obtaining updates" and "complexity of systems of systems scheduling." Altogether these statements are interpreted as schedule inaccuracies eroding the usefulness of schedule management and the difficulties of maintaining accurate schedules.

4.7.9   Cluster 9. Lack of knowledge and Experience

Cluster 9 contains 11 statements. Of those statements nine reference lack of knowledge or experience, not understanding, and not trained or accustomed to when referencing program schedules. One of the remaining statements makes reference to the schools (Air Force Institute of Technology and Defense Acquisition University) and the scheduling methods they instruct. Overall the statements were interpreted as showing a general lack of knowledge and experience within the workforce for accomplishing schedule management.

4.7.10 Cluster 10. Complexity of Schedule Management

Cluster 10 contains 13 statements. The statements use the terms "hard to do," "quickly overwhelm," "receiving and maintaining accurate schedules from many sources," "complexity…makes schedule management difficult," "schedule gets wieldy," "schedule gets abandoned for simpler methods," and "an art to achieve right balance." Together these statements describe schedule management as a difficult and complex practice.

The final cluster map with the cluster labels is shown in Figure 7.
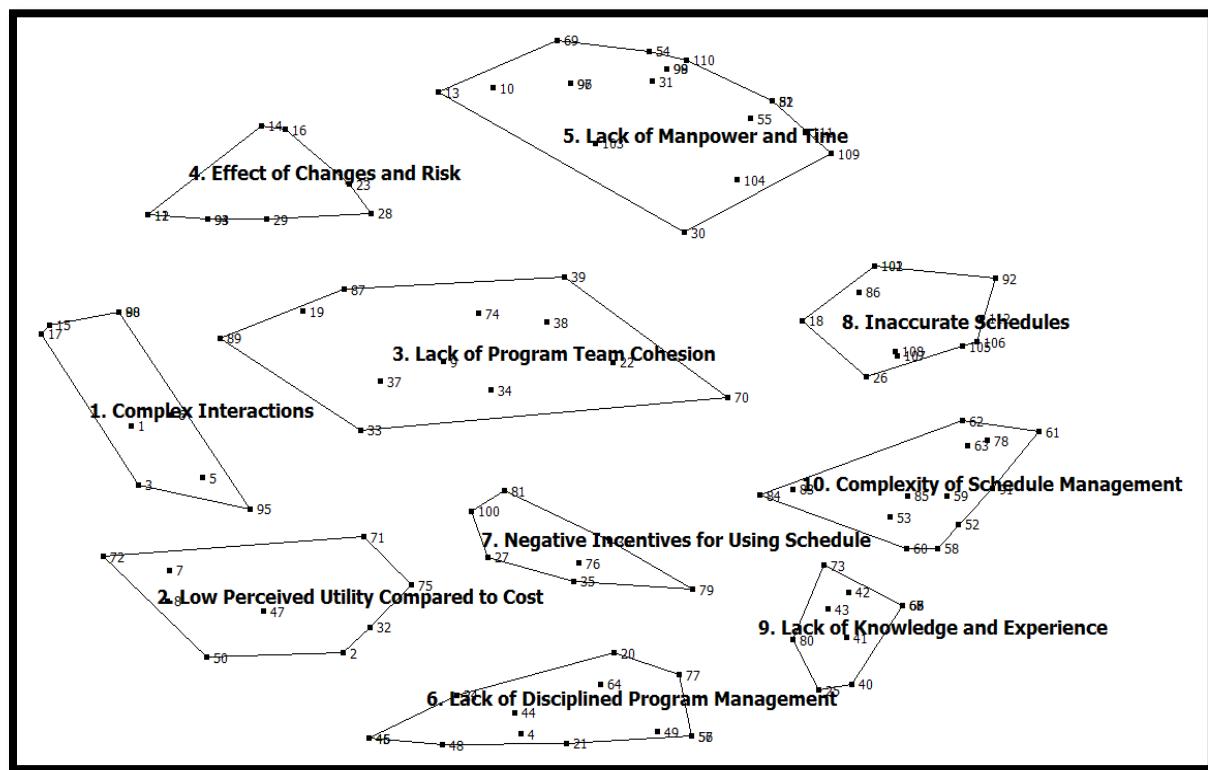
Figure 7 Final Cluster Map with Labels

4.8 Further Interpretation of Results

Several observations can be made based on the 10-cluster map. Interpretations of the

relationships between clusters, cohesiveness of the individual clusters, and higher-level

regions of the concept map will be discussed.

4.8.1 Cluster Relationships

The position of the clusters relative to each other is significant. Cluster (9), Lack of

Knowledge and Experience, is positioned very close to cluster (10), Complexity of

Schedule Management. Intuitively these two clusters should be related. Based on the

statements from the ASC program managers, there appears to be an imbalance between

the knowledge levels regarding schedule management relative to what is required to

effectively manage program schedules. Similarly, a lack of knowledge may relate to a

lack of discipline and negative incentives and so on. With the data available, relationships

between the clusters can only be inferred. Further testing would be required to measure

actual relationships and the strengths of those relationships.

4.8.2 Cluster Cohesiveness

The second observation that can be drawn from the map is about the cohesiveness of the

cluster. The cohesiveness, or tighter cluster, indicates a higher level of agreement among

the sorters about the relatedness of the statements. One can infer that a more cohesive

cluster will likely remain stable if the data was subjected to additional sorts. Clusters that

are less cohesive may see some statements move into different clusters with additional

sorts. While one can attempt to make this judgment by visually interpreting the map, a

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more accurate and effective method is to evaluate the cluster's average bridging value. Every statement is given a bridging value, which is a measure on a scale of (0) to (1). The bridging value indicates how often a statement was sorted together with other statements that are near it on the map, or if it was sorted with other statements that are farther away on the map (Jackson & Trochim, 2002). Lower values indicate a tighter relationship between the statements. Each cluster is measured for the mean and median bridging value of the statements in that cluster. The bridging value for each statement and the cluster's average bridging value can be found in appendix C. The table below shows the clusters in order from smallest (most cohesive) bridging value to largest (least cohesive).

Table 8 Clusters Ranked by Bridging Value

Bridging Value	Cluster
0.09	9. Lack of Knowledge and Experience
0.19	5. Lack of Manpower and Time
0.2	10. Complexity of Schedule Management
0.28	6. Lack of Disciplined Program Management
0.29	7. Negative Incentives for Using Schedules
0.36	3. Lack of Program Team Cohesion
0.36	4. Effect of Changes and Risks
0.36	8. Inaccurate Schedule
0.54	1. Complex Interactions
0.71	2. Low Perceived Utility Compared to Cost

Analysis is done using the average bridging value of the cluster versus visually judging based on cluster size to avoid affects of distortion on the map. Visually, cluster (9) is the most compact. However, just using a visual assessment of the map, clusters (4, 8, or 7)

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would be likely candidates for next most cohesive cluster after (9). Using the average

bridging value cluster (5) is the second most cohesive cluster even though it appears to be

the second largest cluster on the map.

4.8.3   Contribution of Respondents to Clusters

The clusters were analyzed to determine if any were based on the contributions of a

single program manager. As displayed in Table 9 the first row, % of Data Set, shows the

overall contribution of each respondent to the overall data set of 112 statements.

Following that, each cluster was analyzed to determine which respondents contributed

statements to the cluster. The data is displayed as percent of statements contributed to

each cluster.

Table 9 Analysis of Respondent Contribution to Clusters

	Respondent Number			
	1	2	3	4
% of Data Set	20.5	40.2	13.4	25.9
Cluster 1	66.6	0	0	33.3
Cluster 2	33.3	33.3	33.3	0
Cluster 3	25	41.6	16.6	16.6
Cluster 4	55.5	22.2	0	22.2
Cluster 5	11.1	27.7	11.1	50
Cluster 6	23	69.2	7.6	0
Cluster 7	0	42.8	42.8	14.3
Cluster 8	9	9	0	81.8
Cluster 9	0	81.8	18.1	0
Cluster 10	0	61.5	15.4	23.1

Percent Contribution to Cluster

The results of the analysis show that two of the clusters, (1 and 9) were based on the

contribution of two of the respondents. Clusters (2, 4, 6, 7, 8, and 10) were the results of

three respondents. Clusters (3 and 5) received statements from each of the respondents.

4.8.4   Regions of Cluster Map

As discussed during results of multidimensional scaling, the points on the cluster map are not positioned along any predetermined axis. However, it is possible to interpret potential axes within the cluster map due to the fact that the map is based on a multidimensional scaling analysis (Kruskal & Wish, 1978) (Trochim, 1989). Figure 8 shows axes representing the author's interpretation of the overall cluster map. There appear to be two primary axes. The first axis depicts the barriers as spread along a spectrum from internal to external to the organization. On the internal side of the scale, elements like lack of knowledge and lack of discipline are observed. On the external side are the effects of changes, risks, and manning situation. The other axis shows a spread from the tactical challenges of implementing schedule management to the strategic challenges to implementation. At the tactical end, barriers such as inaccurate schedules, time and manpower shortages, as well as the overall complexity of schedule management are observed. The opposite end of this axis deals with difficulties in the strategic realm regarding schedule management. Low perception of utility, the issues with coordinating stakeholders and making decisions (Complex Interactions), and program team cohesion issues fit into this realm.
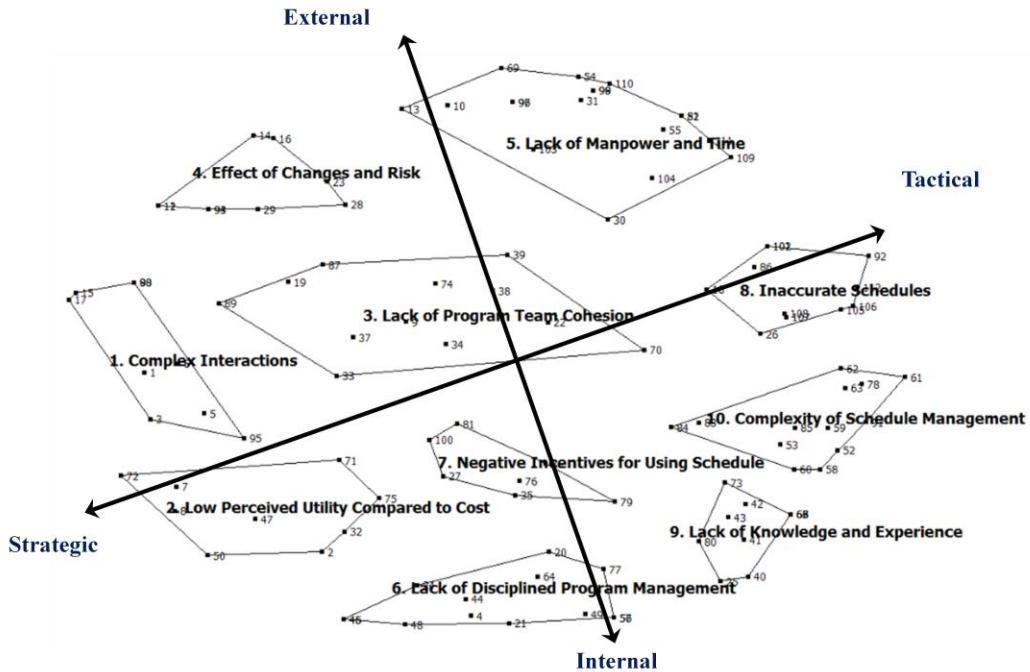
Figure 8 Interpretation of Cluster Map

4.9 Summary

During the course of this research, 112 statements regarding schedule management were collected from four experienced program managers within ASC. The statements were grouped by ten individuals with defense acquisition backgrounds, eight of who were program managers. Results of the ten individual groupings were compiled and analyzed using multidimensional scaling. Cluster analysis was used to identify groups of statements that signified concepts emerging from the group. The results of cluster analysis determined that ten clusters or concepts effectively represented the thinking of the group. These ten concepts represent a group consensus on categories of barriers to schedule management as faced by the sample of program managers within ASC.

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V.   <u>Conclusions and Discussion</u>

5.1 Chapter Overview

Prior research has demonstrated that schedule management is an important tool for efficiently executing a program. However, in practice, program managers have been observed routinely failing to use schedule management for managing their programs. ASC leadership recognized this issue and began an initiative to institutionalize the use of schedule management within the organization. This research effort was undertaken to support that effort by identifying barriers to schedule management as faced by the program managers. A literature review found that the topic was relatively unexplored and could benefit from further research by applying an inductive research method.

In order to identify potential barriers, data was collected via an e-mailed questionnaire from four senior program managers within ASC. The questionnaire asked for their expert opinion on weaknesses of the current schedule management practices and factors causing ineffective schedule use. This resulted in 112 individual statements, which were then analyzed using the concept mapping process. The statements were sorted by eleven individuals with a background in defense acquisition program management or other aspects of the defense acquisition system. In the end, ten of those sorts were used to run multidimensional scaling analysis followed by cluster analysis. Ten clusters were identified within the statement set. Labels for the clusters were created to best capture the theme of statements within each cluster. These labels are the output of the research process as each represents a barrier to schedule management.

5.2 Conclusions on Results

The ten factors identified as barriers to schedule management are the results of an inductive research process. The process used the observations of four experienced ASC program managers and combined the classifications of that data by ten acquisition professionals. At this point, the clusters represent an untested theory of why schedule management is not occurring in a project-based organization.

The barriers to effective schedule use identified by this research are generally consistent with the results from Hameed's work and other literature. Additionally, many of the factors identified have been previously addressed in reports as areas needing improvement within the acquisition system in general (Kadish, 2006) (GAO, 9 Nov 2007) (GAO, 3 Jun 2008). These factors include acquisition workforce training and knowledge, shortage of manpower, changing requirements, high program manager turnover, lack of discipline, and complexity of the system.

The clusters were evaluated for cohesiveness, or level of agreement between the sorters. Lack of Knowledge and Discipline (Cluster 9), Lack of Manpower and Time (Cluster 5), Complexity of Schedule Management (cluster 10), and Lack of Disciplined Program Management (Cluster 6) were the top four most cohesive clusters. These primarily fall into the internal/tactical quadrant of barriers. This may be a reflection of the data sources and sorters who were program managers operating more at the tactical level of the acquisition system. The cohesiveness of the clusters should not be interpreted as a

measure of a barrier's effect on implementation of schedule management. Cohesiveness is strictly a measure of sorter agreement, not of relative importance.

By evaluating the map in its entirety, two axes were identified that appear to separate the barriers on a conceptual level. The first axis is the difference between human and environmental effects on the use of schedule management. The second represents a spread between technical and managerial challenges to implementing schedule management. The map can be used to devise a strategy for improving the use of schedule management within the organization by evaluating the resulting quadrants and clusters within each quadrant. Recommendations for action based on the research results are covered in the next section.

5.2.1   Recommendations for Action

The author's recommendations for action are organized by uses of the concept map from a top-level view to lower levels of abstraction. All recommendations focus on areas that can be either controlled or influenced by ASC.

5.2.2   Use of Map as Communication Tool

The first recommendation is to use the map as a communication tool to raise awareness of the issue and the barriers faced within ASC. Schedule management needs to be recognized as a core process of program management and an effective tool for ensuring program success. There should also be recognition that schedule management is a complex process that requires skill, manpower, and the support of the program team to be

done effectively. The lack of effective schedule management is a complex problem that has many influencing factors. Schedule management, and in a more global sense the ability of ASC to manage programs, is affected by decisions and actions at all levels from within the program teams to senior leadership. A lasting improvement in the use of schedule management within ASC will come as a result of a concerted effort at all levels of the organization.

5.2.3   Recommendations by Quadrant

More specific actions to be taken can be determined by evaluating the quadrants and clusters of the map. The remainder of this section will present the author's recommendations broken out by quadrant.

5.2.3.1 Internal/Tactical

Conceptually this quadrant deals with how the organizations are equipped to handle the tactical aspects of implementing schedule management. There are two clusters to consider in this quadrant: lack of knowledge and experience, and complexity of schedule management. ASC can influence the lack of knowledge by providing training on schedule management. In the long term, ASC can give input to DAU and AFIT School of Systems and Logistics to provide more robust training on schedule management to new employees. Knowledge and experience can be shared through use of knowledge management tools. Practices that have proven effective can be documented in organizational business practices.

The second cluster is barriers due to the complexity of schedule management. To an extent this is just a statement of fact. Schedule management is a tool for dealing with very complex problems of managing large development efforts. The complexity of schedule management is going to be proportional to the complexity of the program being undertaken. If this is an issue, decisions can be made in how programs are structured to reduce the complexity. Strategies such as spiral acquisitions may be useful. Another aspect of schedule management is how it is used as a management tool. ASC can evaluate its practices to reduce the complexity of how management is done. The intent here is to reduce the proliferation of numerous non-integrated program schedules. Recommendations could include conducting program reviews using the same schedule the program uses for monitoring execution. Another recommendation is to maintain a single program schedule at a network accessible site.

5.2.3.2 External/Tactical

Conceptually this quadrant deals with realities of the external environment, which makes it technically more difficult to manage program schedules. The two primary clusters in this quadrant are lack of manpower and time as well as inaccurate schedules. There are a few options for dealing with manpower issues. First, ensure schedule management is prioritized over other activities. This can improve schedule management performance but at the expense of other activities. The second option is to increase manpower across ASC. This is an expensive option and will likely only have minimal effect without also prioritizing schedule management. A third option is to reduce the existing workload to fit the resources at hand by cutting programs. A fourth option is to bring back the scheduler

career field in enough numbers to support the programs. A combination of the first and fourth options is recommended as the easiest to implement within ASC.

The second barrier in this quadrant is inaccurate schedules. There are numerous factors that can cause an inaccurate schedule. Recommendations include reviewing the planning process to ensure accurate schedules are built initially. Once the program is executing, processes for updating and maintaining the schedules need to be reviewed. One particular point that can cause schedule inaccuracy is a poor estimation of activity duration. Maintaining a historical database of program baseline schedules and a schedule that reflects the actual execution of the program could provide a better basis for estimating activity durations.

5.2.3.3 Strategic/External

This quadrant contains three clusters: effects of changes and risk, lack of program team cohesion, and complex interactions. Conceptually this quadrant deals with barriers that are strategic in nature yet external to the organization. The barrier of complex interactions dealt with the issues of numerous stakeholders in the decision process and the interconnections between schedule, cost, and risk when managing a program. Strategies for dealing with this barrier include clearly defining roles, responsibilities, and levels of authority early in the program. Other than that, clear and frequent communication with stakeholders to ensure continued support and approval of the programs direction could be used. To deal with the interaction of schedule, cost, and risk, there should be agreement

among the stakeholders early in the program regarding which factor will take priority in program decisions.

Recommendations for dealing with a lack of program team cohesion include evaluating program team structure, defining roles and responsibilities, and training.

The effect of changes and risk dealt with fluctuating requirements, resources, and the changes driven by unexpected events. While changes and risks may be impossible to remove entirely, strategies can be adopted to minimize the occurrence of changes. First, the impact of changing members of the program team while the project is being planned or executed should be given significant consideration. The same consideration should be given to decisions regarding changes to program funding. Requirements changes can be minimized, putting more attention on ensuring that the program scope and requirements are well defined early in the program lifecycle.

5.2.3.4 Strategic/Internal

This quadrant deals with the strategic barriers to schedule management that occur within the organization. Barriers to schedule management in this quadrant include a low perceived utility of schedule management compared to the cost, negative incentives for using schedule, and a lack of disciplined program management. Recommendations for each of these clusters deal with means of influencing people's attitudes and perceptions of schedule management. The first cluster, low perceived utility compared to cost, contains two key concepts. First, perceptions of utility can be influenced by education,

policies, and increased focus on schedule during program reviews. Costs can be dealt with by making it clear that increased cost for improving schedule management is acceptable or by finding ways of reducing the cost of schedule management.

The cluster, negative incentives for using schedule, indicate that at the program manager's level, there may be a perception that schedules are used as a tool for holding people accountable more so than a tool for managing program execution. A recommendation for dealing with this may be to adopt some of the ideas of Dr. W. Edward Deming (Deming, 1983). While it is a natural management strategy to hold people accountable for their failures as a means to improve the performance of the organization, this is often not very effective. A more effective strategy is to find out what parts of the system are contributing to the failures and fix the system. One well-documented shortcoming of the acquisition system is that programs are often started with overly optimistic baseline schedules and budgets (GAO, 3 Jun 2008). From this we can debate the effectiveness of holding a program manager accountable for missing a schedule date if there was no realistic way of being able to achieve that date. If ASC intends to improve the use of schedule management, it may be better served by rewarding the program teams that demonstrate an understanding of the program schedule and are making effective decisions based on that schedule, even if milestone dates are missed.

The final cluster is lack of disciplined program management. Recommendations for dealing with this barrier are to improve schedule management and project management education for the ASC workforce and then rewarding critical thinking and adherence to a

disciplined process over the "seat of the pants" program management. One tool that may help achieve this is to adopt the Capability Maturity Model® Integration for Acquisition (CMMI-ACQ), which was developed by Carnegie Mellon for Electronic Systems Command (ESC) (Richter, 2008).

5.3 Conclusions on Method

A secondary objective of this research was to evaluate the effectiveness of the concept mapping process for analyzing complex organizational problems. Observations on the utility and limitations of the method are presented below.

5.3.1 Utility

The concept mapping process was effective at bringing together expert inputs from multiple sources, allowing individuals the opportunity to provide their own interpretation, and then creating a graphic representation of the collective thinking of the group. During the course of this research the author was able to participate in a week-long larger group (15 member) process improvement event. The members of the group were very experienced professionals, most with over 20 years working in defense acquisitions. Ultimately the group was trying to figure out what were the barriers to schedule management and which were the most significant barriers, and to create action plans for how to enact organizational change. The author observed that a major challenge in this setting was attempting to gather the combined knowledge and experience of the group and come to an agreement what it all means. Every member of the group had different observations and experiences with the problem as well as a different view of what the

most significant factors were. Group discussions went on for several hours without coming to a firm agreement of what the barriers were or which were most important. The concept mapping process may have been useful at this point. Every member of the team could contribute their observations and have an equal input to determining what the barriers were through their individual sort of the statements. The process would ensure a group consensus was reached, possibly in a shorter time span, and help the group make better use of their time.

5.3.2 Limitations

Several limitations of the concept mapping method were identified in the course of the research. First was the limit on the amount of data that could be analyzed. The software used has a limit of 125 statements, and there is a practical limitation in how many statements a person can effectively sort through. When collecting data using an open-ended survey, it took responses from only four individuals to create 112 statements. Had more program managers responded with a similar level of detail, the researcher would have been required to condense the data before analysis. While methods have been proposed for handling this issue, it does introduce opportunity for reliability issues (Jackson & Trochim, 2002). Data collection for concept mapping is done most often using group brainstorming sessions to create statements. Brainstorming sessions allow more people to participate in generating a manageable number of statements; however, issues with group think and other group dynamics can influence the data collected. A potential way to overcome these limitations would be to collect statements from several

small (less than four member) focus groups. This could allow input from more people but reduce the issues of a large group session.

Another limitation is that the data set is only broken down one level of extraction. When analyzing complex problems it may be useful to run a similar analysis of some of the subcategories to identify the issues affecting that category. There may be some value to blending concept-mapping analysis and root cause analysis techniques when analyzing complex organizational problems. The challenge with complex organizational problems is that there can be many layers of factors contributing to a problem. Concept mapping has proved itself useful in identifying a group consensus on causal factors. By running a similar process on analyzing sub factors, one may be able to identify more specific action areas that the organization needs to address.

Before undertaking a multistage concept-mapping effort as described in the previous paragraph, the researcher must address software tools available to support the effort. The researcher found only one software package designed to support the concept-mapping process from start to finish. At the time of this research, the use of the software is limited to only one project (125 statement data set) per license. Undertaking a multistage research effort using this software will require some financial considerations. The other option is to use standard commercially available software such as Microsoft Excel and SPSS to run the multidimensional scaling and cluster analysis. The challenge here is that putting the data into the table format is a daunting task to say the least if done manually. Some software script would need to be developed to automate the process of creating the

tables. Once the table is built it can be run using available software. Analyzing the data after cluster analysis would also require additional time. Since identifying the appropriate number of clusters is an iterative process, two key tools were found to be very useful in completing that stage of the analysis. First was the ability to quickly produce a map along with the list of statements within each cluster. Second, having a list of the order in which clusters merged as the overall number of clusters was reduced was invaluable. Not having been able to complete the multidimensional scaling and cluster analysis on Excel or SPSS, the researcher cannot tell how difficult these remaining analysis steps would be without the automated tools is the Concept Systems software.

5.3.3 Contributions

This research effort makes several contributions to the body of knowledge. First, it applies a new method to exploring a relatively untouched topic in the field of project management and scheduling. The results lend support to theories of why schedule management is not adopted within a project-based organization. The barriers identified resonate with previous research and literature on the subject but contribute largely by pulling all of the concepts together as the result of a single research effort.

In the course of the research process the author developed a set of rules for unitizing extended text. These rules were presented in Table 5. While they may be simplistic compared to directions given for standard content analysis, they proved effective and straightforward to apply for unitizing short paragraphs. One point of caution when using this for concept mapping: The concept-mapping process works by treating every text unit

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(statement) as an independent thought. There is a serious risk of misconstruing the meaning of the data if it was extracted from a more complex piece such as an extended logical argument (Jackson & Trochim, 2002).

5.4 Recommendations for Future Research

There are several directions for future research based on the results of this effort. First, deductively test the results of this effort. This could be done by creating survey measures of effective schedule management along with measures for each of the ten factors identified in this research and sampling a larger number of program managers. Evaluating the variance explained by the barriers to schedule management on actual implementation of schedule management would provide numerous benefits. First, simply having a measure of effective scheduling would give an organization such as ASC a tool to benchmark schedule management before and after a change effort, as well as periodic testing to ensure levels are maintained. Second, a statistical test could identify which of the factors has a greater impact on schedule management. This could help to further focus efforts on the areas that are having the greatest impact.

Another recommendation is to use the concept-mapping method again to research motivation and incentives within the organization. This seems to be an area that is relatively undefined and could significantly benefit ASC if it was better understood.

VI. Appendices

Appendix A. Statement List

1	Root cause analysis takes time
2	Root cause analysis is often complex
3	Root cause analysis sometimes associates blame
4	often managers incompletely conduct root cause analysis
5	schedule management is meaningless without understanding root causes to issues
6	Schedule of how things will become depends on understanding how things got this way
7	We understand design to cost - process that constrains design options to a fixed cost limit
8	Have we ever considered working with customer to put schedule on same footing as design to cost?
9	Lack of communication
10	Resources are constantly changing
11	Requirements are constantly changing
12	Requirements changes inject flux (stress) into schedules
13	Resource changes inject flux (stress) into schedules
14	Schedule will be effectively used if properly communicated against resource decisions
15	Schedule will be effectively used if properly communicated against requirements decisions
16	Schedule will be effectively used if properly vetted against resource decisions
17	Schedule will be effectively used if properly vetted against requirements decisions
18	Schedules become ineffective if schedule changes are not fully accounted for
19	expectations mismatch
20	mishandling risks
21	unfocused management reactions to schedule change realities
22	Miscommunicated changes
23	schedule anomalies
24	Schedule management is neglected or mostly non-existent at ASC
25	PM practices taught by AFIT/DAU focus on Critical Path Method
26	Critical Path Method doesn't take into account impact of resource requirements on program schedule
27	ASC should consider Critical Chain Methodology
28	Challenge assumptions on task durations
29	schedule lacks protection from unanticipated delays
30	need insights into schedule variance
31	lack basis for justifying program manpower requirements
32	Not wanting to be held accountable
33	schedule represents commitment by every team member to complete defined activities on specified timeline
34	Schedule makes it clear who is or is not contributing to success of the team
35	comfortable for team members to hide in anonymity of team without accountability
36	team members tend to avoid supporting schedule development and maintenance to avoid expectation that they have "bought in" to the schedule
37	every team member is part owner, developer and maintainer of the schedule
38	PM has less direct influence on matrixed personnel
39	move away from true IPTs to mostly matrixed team support
40	Lack of knowledge

41 PMs don't know basic PM tools (like MS Project or IMP/IMS)
42 Engineers, Loggies, contracts managers are not trained or accustomed to developing a schedule
43 Engineers, Loggies, contracts managers are not trained or accustomed to maintaining a schedule
44 lack of senior management focus on program schedules for government activity
45 Senior leaders never ask to see your actual program schedule
46 Senior leaders are interested in top level cartoon of schedule so that is all that gets developed
47 implied assumption that detailed schedule exists to back up cartoon, but it rarely does
48 No negative personal impact to the PM for not using schedule tools
49 system allows "seat of the pants" program management where activity is reactionary
50 Some activities get some additional level of schedule attention
51 Insufficient resources
52 developing integrated schedules is hard to do
53 maintaining integrated schedules is hard to do
54 developing integrated schedules takes more resources than a typical program office is staffed to support so it doesn't get done
55 maintaining integrated schedules takes more resources than a typical program office is staffed to support so it doesn't get done
56 seat of the pants program management can be done on the fly
57 seat of the pants program management requires little or no training to make it up as you go
58 It's just plain hard to do
59 almost anyone can put together a rudimentary schedule for a small project
60 larger projects warrant levels of detail that can quickly overwhelm most of our inexperienced (and experienced) government PMs
61 Schedule development is somewhat of an art to achieve right balance of detail while simultaneously keeping the schedule small enough to manage with available resources
62 When schedule gets to wieldy it becomes ineffective
63 When schedule gets to wieldy it is quickly abandoned for simpler methods
64 ASC abandoned the scheduler skill set years ago
65 Few of today's PMs have the knowledge to develop useful schedules
66 Few of today's PMs have the experience to develop useful schedules
67 Few of today's PMs have the knowledge to maintain useful schedules
68 Few of today's PMs have the experience to maintain useful schedules
69 Time consuming
70 Teams tend to not keep schedule updated
71 Some scheduling tools are not user friendly for quick updates
72 Some scheduling tools are not useful in briefings
73 Some teams don't understand impact of using top level schedules to manage a program
74 Teams don't always know requirements to fulfill a milestone
75 Could add cost to program if contractor develops schedule
76 Could add cost to program if contractor manages schedule
77 Not recognizing that schedule management is essential
78 Not recognizing that schedule management is a full time job
79 Not managing the schedule as an integrated product
80 not reviewing the schedule activity on a routine basis

81	not acting on the schedule on a routine basis
82	Not investing the proper resources to develop the schedule
83	Not using the schedule as a credible tool to forecast
84	weakness of current schedule management practices involve receiving accurate schedules from multiple sources
85	weakness of current schedule management practices involve maintaining accurate schedules from multiple sources
86	obtaining updates and keeping the master schedule current
87	achieving synchronization of schedule issues
88	achieving synchronization of risks from all stakeholders
89	achieving consensus of schedule issues
90	achieving consensus of risks from all stakeholders
91	complexity of system of systems scheduling makes schedule management difficult
92	complexity of system of systems scheduling makes schedule management time consuming to achieve
93	Issues arise in determining what schedule events are associated with identified programmatic risks
94	issues arise in determining what identified programmatic risks are associated with schedule events
95	if the inherent and intimate relationship between risk management, cost management, and schedule management are down played or overlooked a weakness in schedule management is inevitable
96	Time constraints are a key reason that cause outdated schedules
97	Time constraints are a key reason that cause inaccurate schedules
98	lack of manpower is a key reason that cause outdated schedules
99	lack of manpower is a key reason that cause inaccurate schedules
100	Contractors reporting the schedule that is on contract and not what they know to be a more realistic schedule
101	Scheduling errors erode confidence in a master schedule
102	Scheduling errors erode usefulness of a master schedule
103	Time constraints lead to errors which erode confidence in a master schedule
104	Time constraints lead to errors which erode usefulness of a master schedule
105	Improper hierarchy can lead to errors which erode confidence in master schedules
106	Improper hierarchy can lead to errors which erode usefulness of master schedules
107	baseline schedules which do not accurately represent the integrated master plan is a reason for ineffective master schedule
108	baseline schedules which do not accurately represent the SOW/SOO is a reason for ineffective master schedule
109	Schedule issues require a great deal of time from all involved to rectify
110	Schedule issues require a great deal of resources from all involved to rectify
111	Schedule management takes resources away from day to day activities within the IPT
112	Schedule management must be scheduled to be effectively managed

Appendix B. 30 Cluster Statement List With Statement Bridging Values

Cluster 1

Statement #	Statement	Bridging Value
6	Schedule of how things will become depends on understanding how things got this way	0.56
95	if the inherent and intimate relationship between risk management, cost management, and schedule management are down played or overlooked a weakness in schedule management is inevitable	0.56
3	Root cause analysis sometimes associates blame	0.59
5	schedule management is meaningless without understanding root causes to issues	0.77
1	Root cause analysis takes time	0.94
Bridging Value Statistics	Std. Dev.: .15 Minimum: .56 Average: .68 Variance: .02 Maximum: .94 Median: .59	

Cluster 2

Statement #	Statement	Bridging Value
90	team members tend to avoid supporting schedule development and maintenance to avoid expectation that they have "bought in" to the schedule	0.28
88	comfortable for team members to hide in anonymity of team without accountability	0.28
15	Not managing the schedule as an integrated product	0.41
17	Could add cost to program if contractor manages schedule	0.44
Bridging Value Statistics	Std. Dev.: .07 Minimum: .28 Average: .35 Variance: .01 Maximum: .44 Median: .34	

Cluster 3

Statement #	Statement	Bridging Value
32	Not wanting to be held accountable	0.38
75	Could add cost to program if contractor develops schedule	0.44
71	Some scheduling tools are not user friendly for quick updates	0.65
2	Root cause analysis is often complex	0.82
Bridging Value Statistics	Std. Dev.: .17 Minimum: .38 Average: .58 Variance: .03 Maximum: .82 Median: .55	

Appendix B. 30 Cluster Statement List With Statement Bridging Values Continued

Cluster 4

Statement #	Statement	Bridging Value
47	implied assumption that detailed schedule exists to back up cartoon, but it rarely does	0.60
8	Have we ever considered working with customer to put schedule on same footing as design to cost?	0.66
7	We understand design to cost - process that constrains design options to a fixed cost limit	0.81
72	Some scheduling tools are not useful in briefings	0.99
50	Some activities get some additional level of schedule attention	1.00
Bridging Value Statistics	Std. Dev.: .16 Minimum: .60 Average: .81 Variance: .03 Maximum: 1.0 Median: .81	

Cluster 5

Statement #	Statement	Bridging Value
34	team members tend to avoid supporting schedule development and maintenance to avoid expectation that they have "bought in" to the schedule	0.27
37	comfortable for team members to hide in anonymity of team without accountability	0.35
9	Not managing the schedule as an integrated product	0.37
33	Could add cost to program if contractor manages schedule	0.40
Bridging Value Statistics	Std. Dev.: .05 Minimum: .27 Average: .34 Variance: .00 Maximum: .40 Median: .36	

Cluster 6

Statement #	Statement	Bridging Value
87	achieving synchronization of schedule issues	0.37
89	achieving consensus of schedule issues	0.49
19	expectations mismatch	0.50
Bridging Value Statistics	Std. Dev.: .06 Minimum: .37 Average: .46 Variance: .00 Maximum: .50 Median: .49	

Appendix B. 30 Cluster Statement List With Statement Bridging Values Continued

Cluster 7

Statement #	Statement	Bridging Value
70	Teams tend to not keep schedule updated	0.20
22	Miscommunicated changes	0.26
Bridging Value Statistics	Std. Dev.: .03 Minimum: .20 Average: .23 Variance: .00 Maximum: .26 Median: .37	

Cluster 8

Statement #	Statement	Bridging Value
74	Teams don't always know requirements to fulfill a milestone	0.35
39	move away from true IPTs to mostly matrixed team support	0.37
38	PM has less direct influence on matrixed personnel	0.42
Bridging Value Statistics	Std. Dev.: .03 Minimum: .35 Average: .38 Variance: .00 Maximum: .42 Median: .37	

Cluster 9

Statement #	Statement	Bridging Value
93	Issues arise in determining what schedule events are associated with identified programmatic risks	0.22
94	issues arise in determining what identified programmatic risks are associated with schedule events	0.22
11	Requirements are constantly changing	0.30
12	Requirements changes inject flux (stress) into schedules	0.30
29	schedule lacks protection from unanticipated delays	0.44
Bridging Value Statistics	Std. Dev.: .08 Minimum: .22 Average: .30 Variance: .01 Maximum: .44 Median: .30	

Cluster 10

Statement #	Statement	Bridging Value
14	Schedule will be effectively used if properly communicated against resource decisions	0.42
16	Schedule will be effectively used if properly vetted against resource decisions	0.45
Bridging Value Statistics	Std. Dev.: ..02 Minimum: .42 Average: ..43 Variance: .00 Maximum: .45 Median: .43	

Appendix B. 30 Cluster Statement List With Statement Bridging Values Continued

Cluster 11

Statement #	Statement	Bridging Value
23	schedule anomalies	0.43
28	Challenge assumptions on task durations	0.48
Bridging Value Statistics	Std. Dev.: .03 Minimum: .43 Average: .46 Variance: .00 Maximum: .48 Median: .46	

Cluster 12

Statement #	Statement	Bridging Value
10	Resources are constantly changing	0.20
13	Resource changes inject flux (stress) into schedules	0.29
Bridging Value Statistics	Std. Dev.: .04 Minimum: .20 Average: .24 Variance: .00 Maximum: .29 Median: .24	

Cluster 13

Statement #	Statement	Bridging Value
97	Time constraints are a key reason that cause inaccurate schedules	0.10
96	Time constraints are a key reason that cause outdated schedules	0.10
69	Time consuming	0.18
103	Time constraints lead to errors which erode confidence in a master schedule	0.27
Bridging Value Statistics	Std. Dev.: .07 Minimum: .10 Average: .16 Variance: .01 Maximum: .27 Median: .14	

Cluster 14

Statement #	Statement	Bridging Value
99	lack of manpower is a key reason that cause inaccurate schedules	0.00
98	lack of manpower is a key reason that cause outdated schedules	0.00
110	Schedule issues require a great deal of resources from all involved to rectify	0.03
54	developing integrated schedules takes more resources than a typical program office is staffed to support so it doesn't get done	0.06
31	lack basis for justifying program manpower requirements	0.16
Bridging Value Statistics	Std. Dev.: .06 Minimum: .00 Average: .05 Variance: .00 Maximum: .16 Median: .03	

Appendix B. 30 Cluster Statement List With Statement Bridging Values Continued

Cluster 15

Statement #	Statement	Bridging Value
104	Time constraints lead to errors which erode usefulness of a master schedule	0.32
30	need insights into schedule variance	0.36
Bridging Value Statistics	Std. Dev.: .02 Minimum: .32 Average: .34 Variance: .00 Maximum: .36 Median: .34	

Cluster 16

Statement #	Statement	Bridging Value
51	Insufficient resources	0.13
82	Not investing the proper resources to develop the schedule	0.13
55	maintaining integrated schedules takes more resources than a typical program office is staffed to support so it doesn't get done	0.20
111	Schedule management takes resources away from day to day activities within the IPT	0.38
109	Schedule issues require a great deal of time from all involved to rectify	0.46
Bridging Value Statistics	Std. Dev.: .13 Minimum: .13 Average: .26 Variance: .02 Maximum: .46 Median: .20	

Cluster 17

Statement #	Statement	Bridging Value
21	unfocused management reactions to schedule change realities	0.20
44	lack of senior management focus on program schedules for government activity	0.28
48	No negative personal impact to the PM for not using schedule tools	0.38
24	Schedule management is neglected or mostly non-existent at ASC	0.41
4	often managers incompletely conduct root cause analysis	0.64
Bridging Value Statistics	Std. Dev.: .15 Minimum: .20 Average: .38 Variance: .02 Maximum: 64 Median: .38	

Cluster 18

Statement #	Statement	Bridging Value
46	Senior leaders are interested in top level cartoon of schedule so that is all that gets developed	0.22
45	Senior leaders never ask to see your actual program schedule	0.22
Bridging Value Statistics	Std. Dev.: .00 Minimum: .22 Average: .22 Variance: .00 Maximum: .22 Median: .22	

Appendix B. 30 Cluster Statement List With Statement Bridging Values Continued

Cluster 19

Statement #	Statement	Bridging Value
77	Not recognizing that schedule management is essential	0.20
64	ASC abandoned the scheduler skill set years ago	0.29
20	mishandling risks	0.38
Bridging Value Statistics	Std. Dev.: .07 Minimum: .20 Average: .29 Variance: .01 Maximum: .38 Median: .29	

Cluster 20

Statement #	Statement	Bridging Value
56	seat of the pants program management can be done on the fly	0.12
57	seat of the pants program management requires little or no training to make it up as you go	0.12
49	system allows "seat of the pants" program management where activity is reactionary	0.23
Bridging Value Statistics	Std. Dev.: .05 Minimum: .12 Average: .16 Variance: .00 Maximum: .23 Median: .12	

Cluster 21

Statement #	Statement	Bridging Value
100	Contractors reporting the schedule that is on contract and not what they know to be a more realistic schedule	0.32
81	not acting on the schedule on a routine basis	0.40
27	ASC should consider Critical Chain Methodology	0.44
Bridging Value Statistics	Std. Dev.: .05 Minimum: .32 Average: .39 Variance: .00 Maximum: .44 Median: .40	

Appendix B. 30 Cluster Statement List With Statement Bridging Values Continued

Cluster 22

Statement #	Statement	Bridging Value
36	team members tend to avoid supporting schedule development and maintenance to avoid expectation that they have "bought in" to the schedule	0.18
35	comfortable for team members to hide in anonymity of team without accountability	0.19
79	Not managing the schedule as an integrated product	0.23
76	Could add cost to program if contractor manages schedule	0.26
Bridging Value Statistics	Std. Dev.: .03 Minimum: .18 Average: .21 Variance: .00 Maximum: .26 Median: .21	

Cluster 23

Statement #	Statement	Bridging Value
18	Schedules become ineffective if schedule changes are not fully accounted for	0.31
86	obtaining updates and keeping the master schedule current	0.32
101	Scheduling errors erode confidence in a master schedule	0.43
102	Scheduling errors erode usefulness of a master schedule	0.43
Bridging Value Statistics	Std. Dev.: .06 Minimum: .31 Average: .37 Variance: .00 Maximum: .43 Median: .38	

Cluster 24

Statement #	Statement	Bridging Value
107	baseline schedules which do not accurately represent the integrated master plan is a reason for ineffective master schedule	0.26
108	baseline schedules which do not accurately represent the SOW/SOO is a reason for ineffective master schedule	0.29
26	Critical Path Method doesn't take into account impact of resource requirements on program schedule	0.37
Bridging Value Statistics	Std. Dev.: .05 Minimum: .26 Average: ..30 Variance: .00 Maximum: .37 Median: .29	

Appendix B. 30 Cluster Statement List With Statement Bridging Values Continued

Cluster 25

Statement #	Statement	Bridging Value
106	Improper hierarchy can lead to errors which erode usefulness of master schedules	0.27
105	Improper hierarchy can lead to errors which erode confidence in master schedules	0.28
92	complexity of system of systems scheduling makes schedule management time consuming to achieve	0.46
112	Schedule management must be scheduled to be effectively managed	0.60
Bridging Value Statistics	Std. Dev.: .14　　　Minimum: .27　　　Average: .40 Variance: .02　　　Maximum: .60　　　Median: .37	

Cluster 26

Statement #	Statement	Bridging Value
41	PMs don't know basic PM tools (like MS Project or IMP/IMS)	0.05
40	Lack of knowledge	0.09
80	not reviewing the schedule activity on a routine basis	0.20
25	PM practices taught by AFIT/DAU focus on Critical Path Method	0.24
Bridging Value Statistics	Std. Dev.: .08　　　Minimum: .05　　　Average: .14 Variance: .01　　　Maximum: .24　　　Median: .14	

Cluster 27

Statement #	Statement	Bridging Value
66	Few of today's PMs have the experience to develop useful schedules	0.03
67	Few of today's PMs have the knowledge to maintain useful schedules	0.03
65	Few of today's PMs have the knowledge to develop useful schedules	0.03
68	Few of today's PMs have the experience to maintain useful schedules	0.03
42	Engineers, Loggies, contracts managers are not trained or accustomed to developing a schedule	0.06
73	Some teams don't understand impact of using top level schedules to manage a program	0.10
43	Engineers, Loggies, contracts managers are not trained or accustomed to maintaining a schedule	0.16
Bridging Value Statistics	Std. Dev.: .05　　　Minimum: .03　　　Average: .06 Variance: .00　　　Maximum: .16　　　Median: .03	

Appendix B. 30 Cluster Statement List With Statement Bridging Values Continued

Cluster 28

Statement #	Statement	Bridging Value
60	larger projects warrant levels of detail that can quickly overwhelm most of our inexperienced (and experienced) government PMs	0.04
58	It's just plain hard to do	0.07
53	maintaining integrated schedules is hard to do	0.07
85	weakness of current schedule management practices involve maintaining accurate schedules from multiple sources	0.15
52	developing integrated schedules is hard to do	0.17
91	complexity of system of systems scheduling makes schedule management difficult	0.19
59	almost anyone can put together a rudimentary schedule for a small project	0.30

Bridging Value Statistics	Std. Dev.: .08 Minimum: .04 Average: .14 Variance: .01 Maximum: .30 Median: .15

Cluster 29

Statement #	Statement	Bridging Value
84	weakness of current schedule management practices involve receiving accurate schedules from multiple sources	0.14
83	Not using the schedule as a credible tool to forecast	0.26

Bridging Value Statistics	Std. Dev.: .06 Minimum: .14 Average: .20 Variance: .00 Maximum: .26 Median: .20

Cluster 30

Statement #	Statement	Bridging Value
62	When schedule gets to wieldy it becomes ineffective	0.22
63	When schedule gets to wieldy it is quickly abandoned for simpler methods	0.26
78	Not recognizing that schedule management is a full time job	0.35
61	Schedule development is somewhat of an art to achieve right balance of detail while simultaneously keeping the schedule small enough to manage with available resources	0.42

Bridging Value Statistics	Std. Dev.: .08 Minimum: .22 Average: .31 Variance: .01 Maximum: .42 Median: .30

Appendix C. 10 Cluster Statement List With Statement Bridging Values

Cluster 1: Complex Interactions

Statement #	Statement	Bridging Value
88	achieving synchronization of risks from all stakeholders	0.28
90	achieving consensus of risks from all stakeholders	0.28
15	Schedule will be effectively used if properly communicated against requirements decisions	0.41
17	Schedule will be effectively used if properly vetted against requirements decisions	0.44
6	Schedule of how things will become depends on understanding how things got this way	0.56
95	if the inherent and intimate relationship between risk management, cost management, and schedule management are down played or overlooked a weakness in schedule management is inevitable	0.56
3	Root cause analysis sometimes associates blame	0.59
5	schedule management is meaningless without understanding root causes to issues	0.77
1	Root cause analysis takes time	0.94
Bridging Value Statistics	Std. Dev.: .2 Minimum: .28 Average: .54 Variance: .04 Maximum: .94 Median: .56	

Cluster 2: Low Perceived Utility Compared to Cost

Statement #	Statement	Bridging Value
32	Not wanting to be held accountable	0.38
75	Could add cost to program if contractor develops schedule	0.44
47	implied assumption that detailed schedule exists to back up cartoon, but it rarely does	0.6
71	Some scheduling tools are not user friendly for quick updates	0.65
8	Have we ever considered working with customer to put schedule on same footing as design to cost?	0.66
7	We understand design to cost - process that constrains design options to a fixed cost limit	0.81
2	Root cause analysis is often complex	0.82
72	Some scheduling tools are not useful in briefings	0.99
50	Some activities get some additional level of schedule attention	1
Bridging Value Statistics	Std. Dev.: .2 Minimum: .38 Average: .71 Variance: .04 Maximum: 1.00 Median: .66	

Appendix C. 10 Cluster Statement List With Statement Bridging Values Continued

Cluster 3: Lack of Program Team Cohesion

Statement #	Statement	Bridging Value
70	Teams tend to not keep schedule updated	0.2
22	Miscommunicated changes	0.26
34	Schedule makes it clear who is or is not contributing to success of the team	0.27
37	every team member is part owner, developer and maintainer of the schedule	0.35
74	Teams don't always know requirements to fulfill a milestone	0.35
39	move away from true IPTs to mostly matrixed team support	0.37
9	Lack of communication	0.37
87	achieving synchronization of schedule issues	0.37
33	schedule represents commitment by every team member to complete defined activities on specified timeline	0.4
38	PM has less direct influence on matrixed personnel	0.42
89	achieving consensus of schedule issues	0.49
19	expectations mismatch	0.5
Bridging Value Statistics	Std. Dev.: .08 Minimum: .2 Average: .36 Variance: .01 Maximum: .5 Median: .37	

Cluster 4: Effect of Changes and Risk

Statement #	Statement	Bridging Value
93	Issues arise in determining what schedule events are associated with identified programmatic risks	0.22
94	issues arise in determining what identified programmatic risks are associated with schedule events	0.22
12	Requirements changes inject flux (stress) into schedules	0.3
11	Requirements are constantly changing	0.3
14	Schedule will be effectively used if properly communicated against resource decisions	0.42
23	schedule anomalies	0.43
29	schedule lacks protection from unanticipated delays	0.44
16	Schedule will be effectively used if properly vetted against resource decisions	0.45
28	Challenge assumptions on task durations	0.48
Bridging Value Statistics	Std. Dev.: .1 Minimum: .22 Average: .36 Variance: .01 Maximum: .48 Median: .42	

Appendix C. 10 Cluster Statement List With Statement Bridging Values Continued

Cluster 5: Lack of Manpower and Time

Statement #	Statement	Bridging Value
98	lack of manpower is a key reason that cause outdated schedules	0
99	lack of manpower is a key reason that cause inaccurate schedules	0
110	Schedule issues require a great deal of resources from all involved to rectify	0.03
54	developing integrated schedules takes more resources than a typical program office is staffed to support so it doesn't get done	0.06
96	Time constraints are a key reason that cause outdated schedules	0.1
97	Time constraints are a key reason that cause inaccurate schedules	0.1
51	Insufficient resources	0.13
82	Not investing the proper resources to develop the schedule	0.13
31	lack basis for justifying program manpower requirements	0.16
69	Time consuming	0.18
10	Resources are constantly changing	0.2
55	maintaining integrated schedules takes more resources than a typical program office is staffed to support so it doesn't get done	0.2
103	Time constraints lead to errors which erode confidence in a master schedule	0.27
13	Resource changes inject flux (stress) into schedules	0.29
104	Time constraints lead to errors which erode usefulness of a master schedule	0.32
30	need insights into schedule variance	0.36
111	Schedule management takes resources away from day to day activities within the IPT	0.38
109	Schedule issues require a great deal of time from all involved to rectify	0.46

Bridging Value Statistics	Std. Dev.: .13 Variance: .02	Minimum: .0 Maximum: .46	Average: .19 Median: .17

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Cluster 6: Lack of Disciplined Program Management

Statement #	Statement	Bridging Value
57	seat of the pants program management requires little or no training to make it up as you go	0.12
56	seat of the pants program management can be done on the fly	0.12
77	Not recognizing that schedule management is essential	0.2
21	unfocused management reactions to schedule change realities	0.2
46	Senior leaders are interested in top level cartoon of schedule so that is all that gets developed	0.22
45	Senior leaders never ask to see your actual program schedule	0.22
49	system allows "seat of the pants" program management where activity is reactionary	0.23
44	lack of senior management focus on program schedules for government activity	0.28
64	ASC abandoned the scheduler skill set years ago	0.29
20	mishandling risks	0.38
48	No negative personal impact to the PM for not using schedule tools	0.38
24	Schedule management is neglected or mostly non-existent at ASC	0.41
4	often managers incompletely conduct root cause analysis	0.64
Bridging Value Statistics	Std. Dev.: .14 Minimum: .12 Average: .28 Variance: .02 Maximum: .64 Median: .23	

Cluster 7: Negative Incentives for Using Schedule

Statement #	Statement	Bridging Value
36	team members tend to avoid supporting schedule development and maintenance to avoid expectation that they have "bought in" to the schedule	0.18
35	comfortable for team members to hide in anonymity of team without accountability	0.19
79	Not managing the schedule as an integrated product	0.23
76	Could add cost to program if contractor manages schedule	0.26
100	Contractors reporting the schedule that is on contract and not what they know to be a more realistic schedule	0.32
81	not acting on the schedule on a routine basis	0.4
27	ASC should consider Critical Chain Methodology	0.44
Bridging Value Statistics	Std. Dev.: .1 Minimum: .18 Average: .29 Variance: .01 Maximum: .44 Median: .26	

Appendix C. 10 Cluster Statement List With Statement Bridging Values
Continued

Cluster 8: Inaccurate Schedules

Statement #	Statement	Bridging Value
107	baseline schedules which do not accurately represent the integrated master plan is a reason for ineffective master schedule	0.26
106	Improper hierarchy can lead to errors which erode usefulness of master schedules	0.27
105	Improper hierarchy can lead to errors which erode confidence in master schedules	0.28
108	baseline schedules which do not accurately represent the SOW/SOO is a reason for ineffective master schedule	0.29
18	Schedules become ineffective if schedule changes are not fully accounted for	0.31
86	obtaining updates and keeping the master schedule current	0.32
26	Critical Path Method doesn't take into account impact of resource requirements on program schedule	0.37
101	Scheduling errors erode confidence in a master schedule	0.43
102	Scheduling errors erode usefulness of a master schedule	0.43
92	complexity of system of systems scheduling makes schedule management time consuming to achieve	0.46
112	Schedule management must be scheduled to be effectively managed	0.6
Bridging Value Statistics	Std. Dev.: .1 Minimum: .26 Average: .36 Variance: .01 Maximum: .60 Median: .32	

Cluster 9: Lack of Knowledge and Experience

Statement #	Statement	Bridging Value
67	Few of today's PMs have the knowledge to maintain useful schedules	0.03
66	Few of today's PMs have the experience to develop useful schedules	0.03
65	Few of today's PMs have the knowledge to develop useful schedules	0.03
68	Few of today's PMs have the experience to maintain useful schedules	0.03
41	PMs don't know basic PM tools (like MS Project or IMP/IMS)	0.05
42	Engineers, Loggies, contracts managers are not trained or accustomed to developing a schedule	0.06
40	Lack of knowledge	0.09
73	Some teams don't understand impact of using top level schedules to manage a program	0.1
43	Engineers, Loggies, contracts managers are not trained or accustomed to maintaining a schedule	0.16
80	not reviewing the schedule activity on a routine basis	0.2
25	PM practices taught by AFIT/DAU focus on Critical Path Method	0.24
Bridging Value Statistics	Std. Dev.: .07 Minimum: .03 Average: .09 Variance: .01 Maximum: .24 Median: .06	

Appendix C. 10 Cluster Statement List With Statement Bridging Values Continued

Cluster 10: Complexity of Schedule Management

Statement #	Statement	Bridging Value
60	larger projects warrant levels of detail that can quickly overwhelm most of our inexperienced (and experienced) government PMs	0.04
58	It's just plain hard to do	0.07
53	maintaining integrated schedules is hard to do	0.07
84	weakness of current schedule management practices involve receiving accurate schedules from multiple sources	0.14
85	weakness of current schedule management practices involve maintaining accurate schedules from multiple sources	0.15
52	developing integrated schedules is hard to do	0.17
91	complexity of system of systems scheduling makes schedule management difficult	0.19
62	When schedule gets to wieldy it becomes ineffective	0.22
83	Not using the schedule as a credible tool to forecast	0.26
63	When schedule gets to wieldy it is quickly abandoned for simpler methods	0.26
59	almost anyone can put together a rudimentary schedule for a small project	0.3
78	Not recognizing that schedule management is a full time job	0.35
61	Schedule development is somewhat of an art to achieve right balance of detail while simultaneously keeping the schedule small enough to manage with available resources	0.42
Bridging Value Statistics	Std. Dev.: .11　　Minimum: .04　　Average: .2 Variance: .01　　Maximum: .42　　Median: .19	

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Vita

Captain Gregory Voth was born in Red Wing, Minnesota. In 1996, he graduated from Winona Senior High School. Afterward he went to college at the University of St. Thomas in St. Paul, Minnesota, where he was also a Cadet in the Air Force Officer Training Corps Detachment 410. He graduated with a Bachelor of Arts degree in Physics in May 2000 and received his commission in the US Air Force. After commissioning he was selected for the Operational Experience tour program with an initial operational tour as an Intelligence Officer before transitioning to an Acquisition Program Manager career. He was assigned as an Active Duty at Detachment officer at Detachment 410 from June through October 2000 while awaiting Intelligence Officer Training at Goodfellow Air Force Base, Texas. Captain Voth attended the Intelligence officer training course from November 2000 through July 2001. Following graduation he was assigned to the 18th Operational Support Squadron, Kadena Air Base, Okinawa, Japan. While there he supported the 18th Operational Support Squadron, the 67th Fighter Squadron, and deployed to the 405th Expeditionary Operational Support Squadron for Operations Enduring Freedom and Iraqi Freedom. Following the operational tour, in August of 2004, Captain Voth was assigned to the 504th Aircraft Sustainment Squadron, where he progressed to the Lead A-10 Avionics Program Manager. In August 2007 he entered the Graduate School of Engineering and Management, Air Force Institute of Technology, to obtain a Master's Degree in Research and Development Management. Upon graduation, Captain Voth will be assigned as a Program Manager at the Air Armament Center, Eglin Air Force Base, Florida.

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14. ABSTRACT
Barriers to adoption of schedule management processes are a matter of serious concern to the acquisition community. Schedule management has been widely accepted to contribute to the successful execution of complicated system development processes since the 1950s. However, studies of recent acquisition failures illustrate that over the last 15 years, there has been significant internal resistance to the adoption of schedule management processes. This exploratory effort used concept mapping to identify and classify the types of barriers existing in the Aeronautical Systems Center (ASC). A series of open-ended questions were posed to four experienced program managers in ASC. Units of Analysis were extracted from the survey responses, and grouped and sorted by a representative set of proxy sorters. Multidimensional scaling was applied to the sorted groups to indentify affinity of the responses, and cluster analysis was employed to identify emerging themes from the program manager responses. The results indicated 10 barrier groups, which can be mapped using two conceptual axes (internal-external, and tactical-strategic). As a result of this analysis, a series of focused recommendations are provided to the ASC Acquisition Center of Excellence to improve acceptance and adoption of schedule management practices.

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